Evaluating Effects of Wastewater and Agriculture on South Delta Salinity (EC)

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DSM2 Users Group

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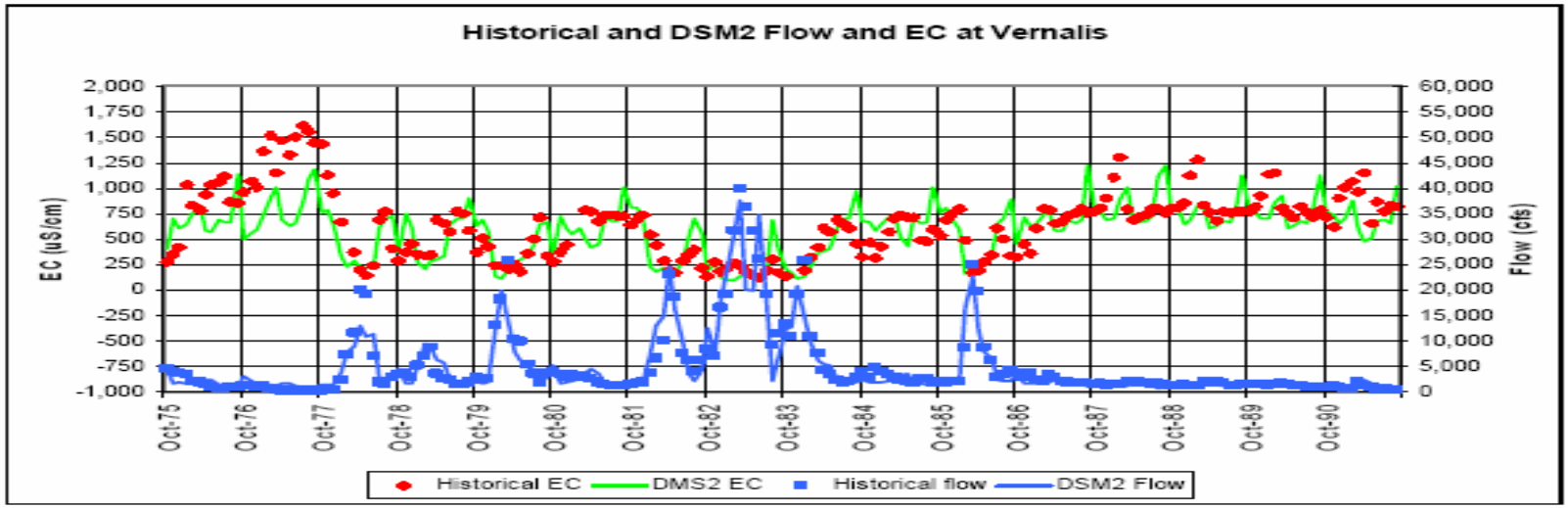
Flow and Salinity Relationships

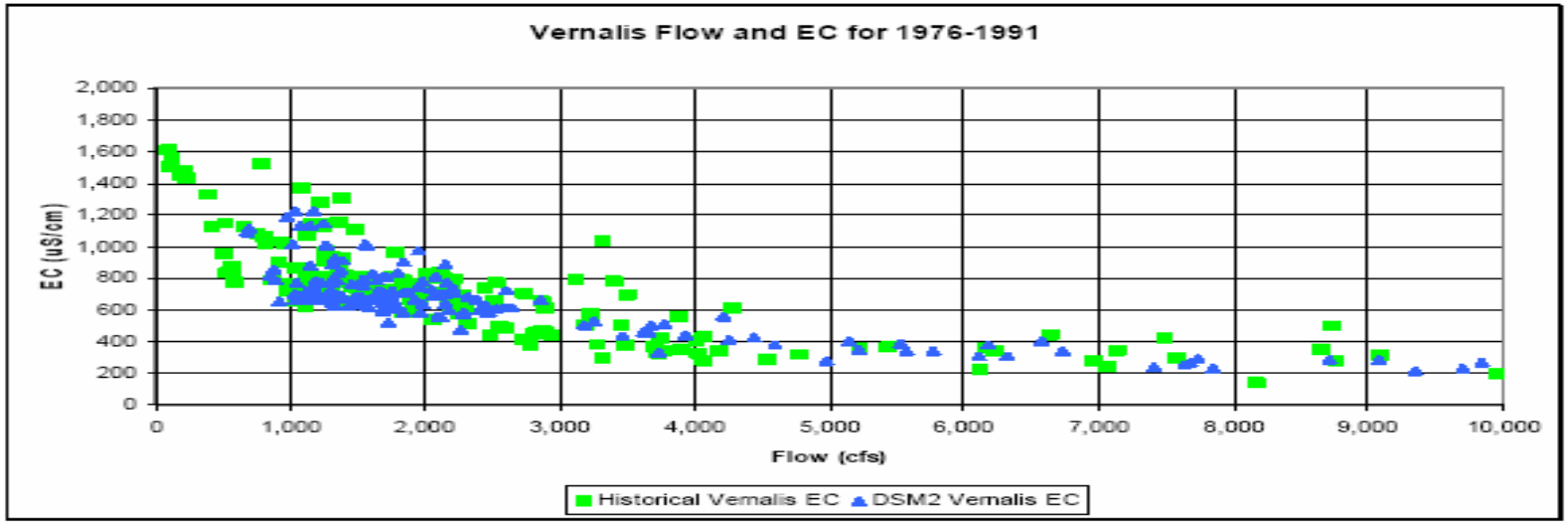
- Load (tons/day) = 0.00175*flow(cfs)*EC(uS/cm)
- SJR salt load = 500,000 to 1,500,000 tons/year
- Ag diversion/return effect on EC = Upstream EC *flow/(flow-diversion) if all salt returned to river
- Wastewater EC effect = Discharge* (Effluent EC-River EC)/(Discharge + River Flow)
- Wastewater EC effect = Excess EC/(dilution +1) where dilution = river flow/discharge

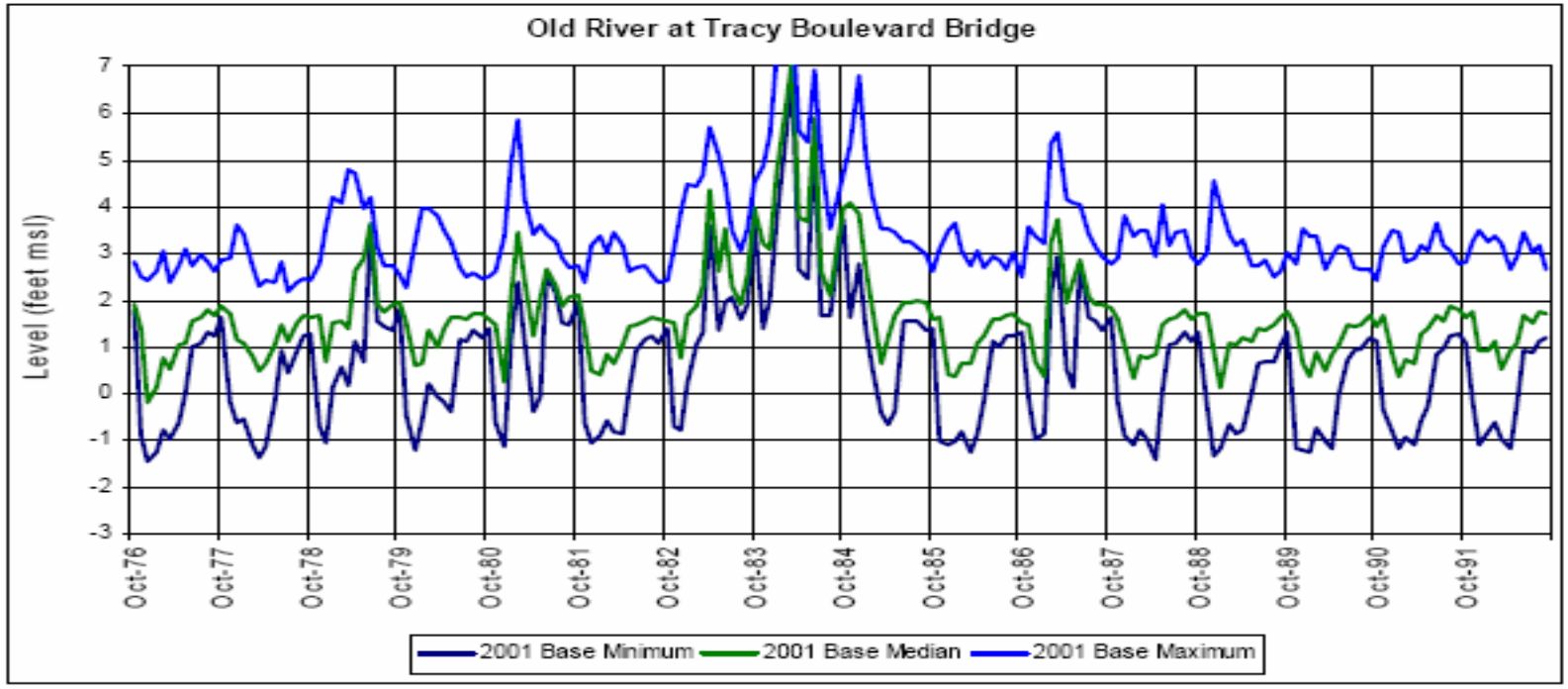
DSM2 South Delta EC Factors

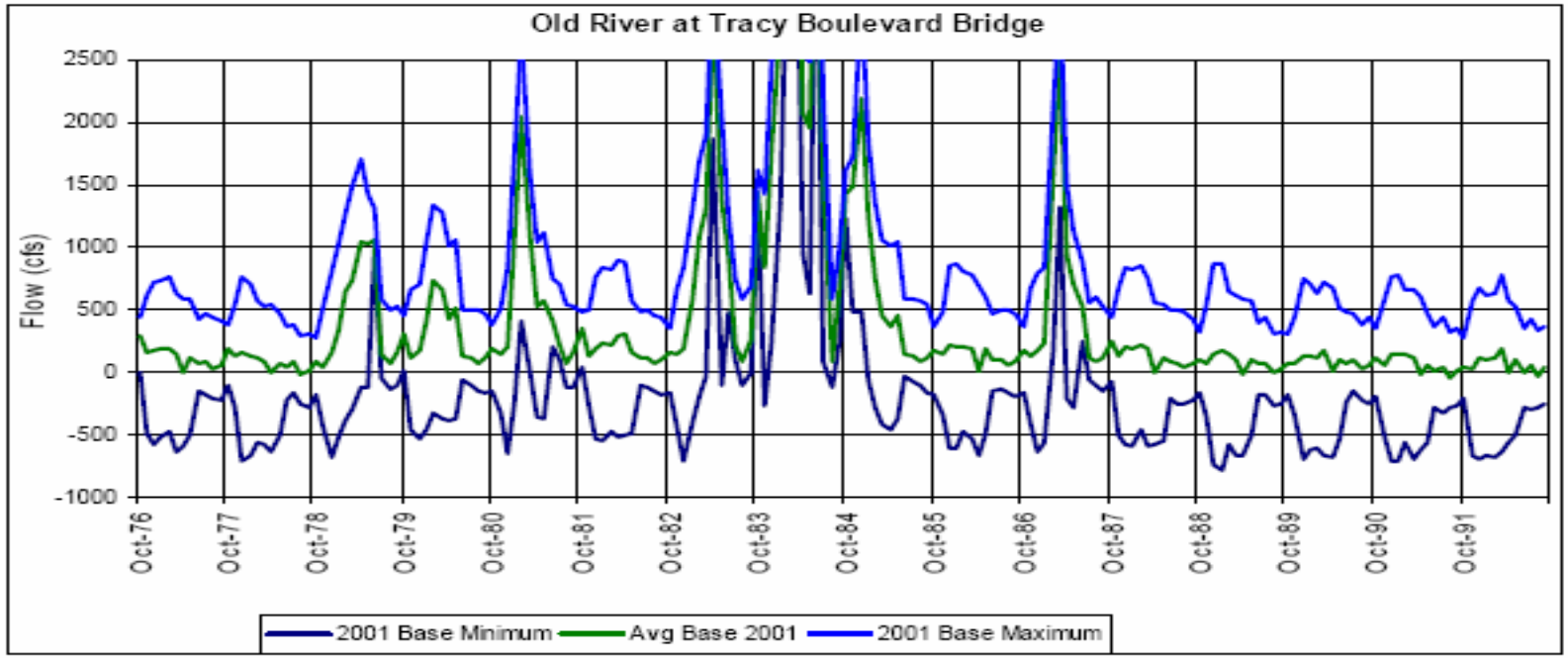
- SJR Inflow EC
- Tidal flows and tidal flow splits
- Agricultural Diversions
- Agricultural Drainage flows and EC
- Wastewater flows and EC

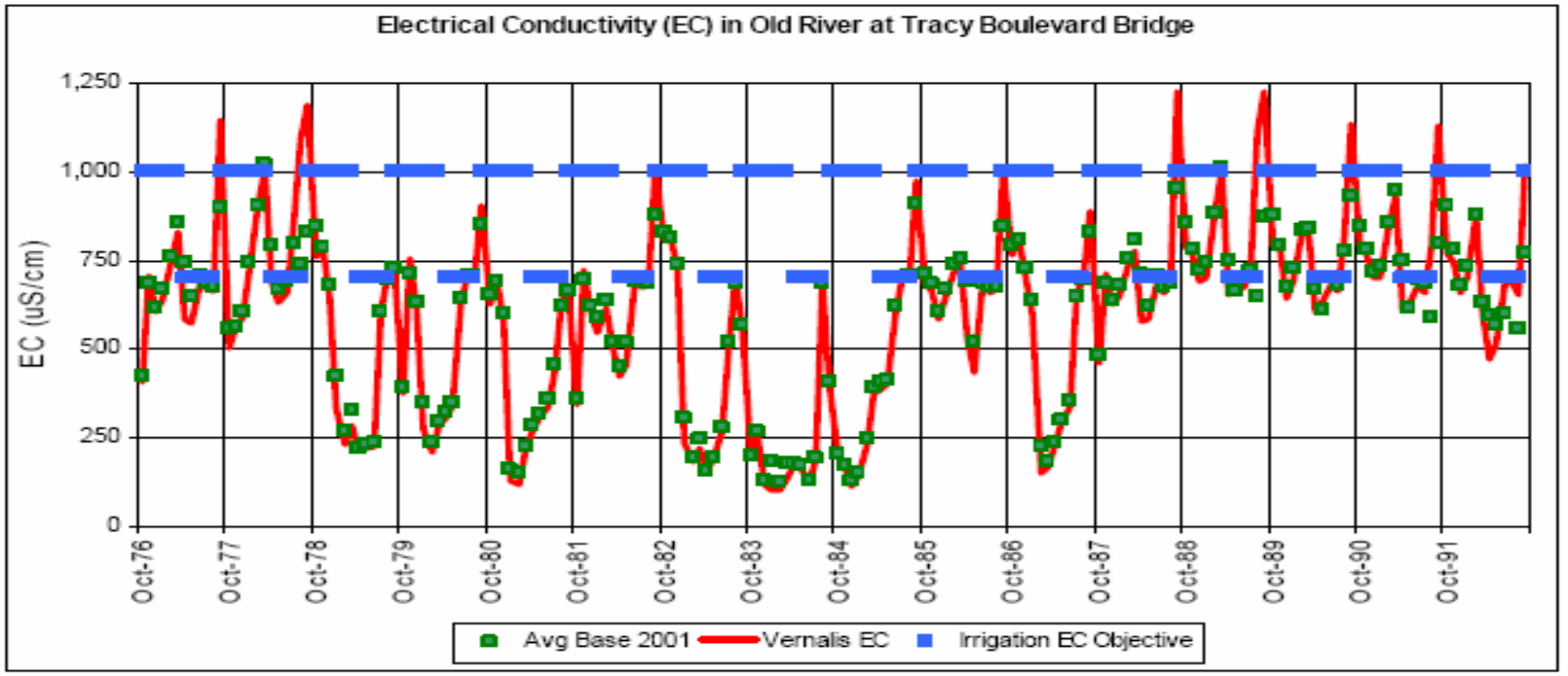
San Joaquin River Vernalis EC

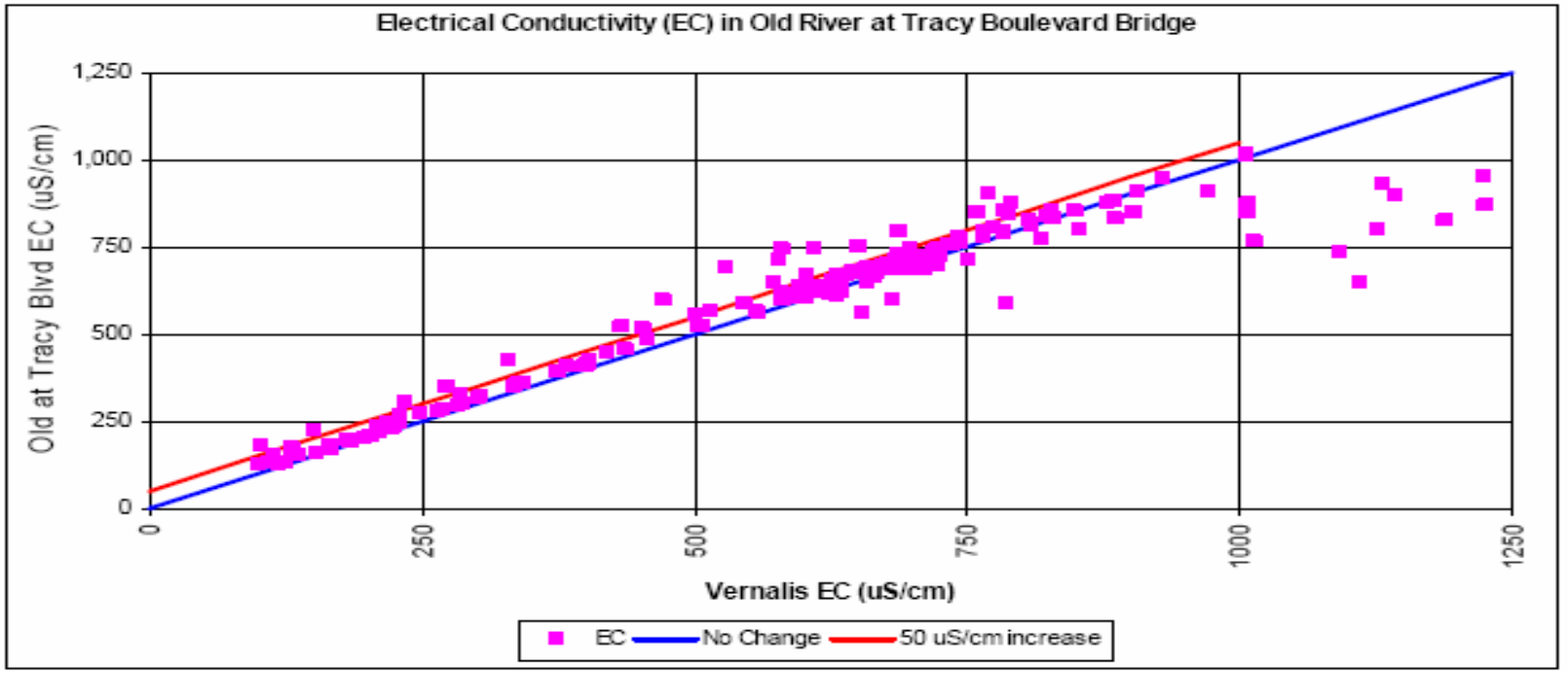


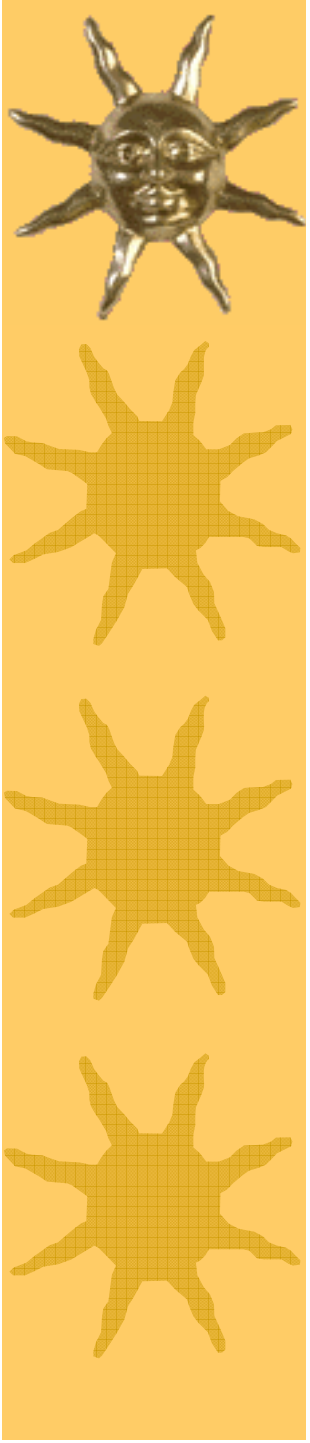


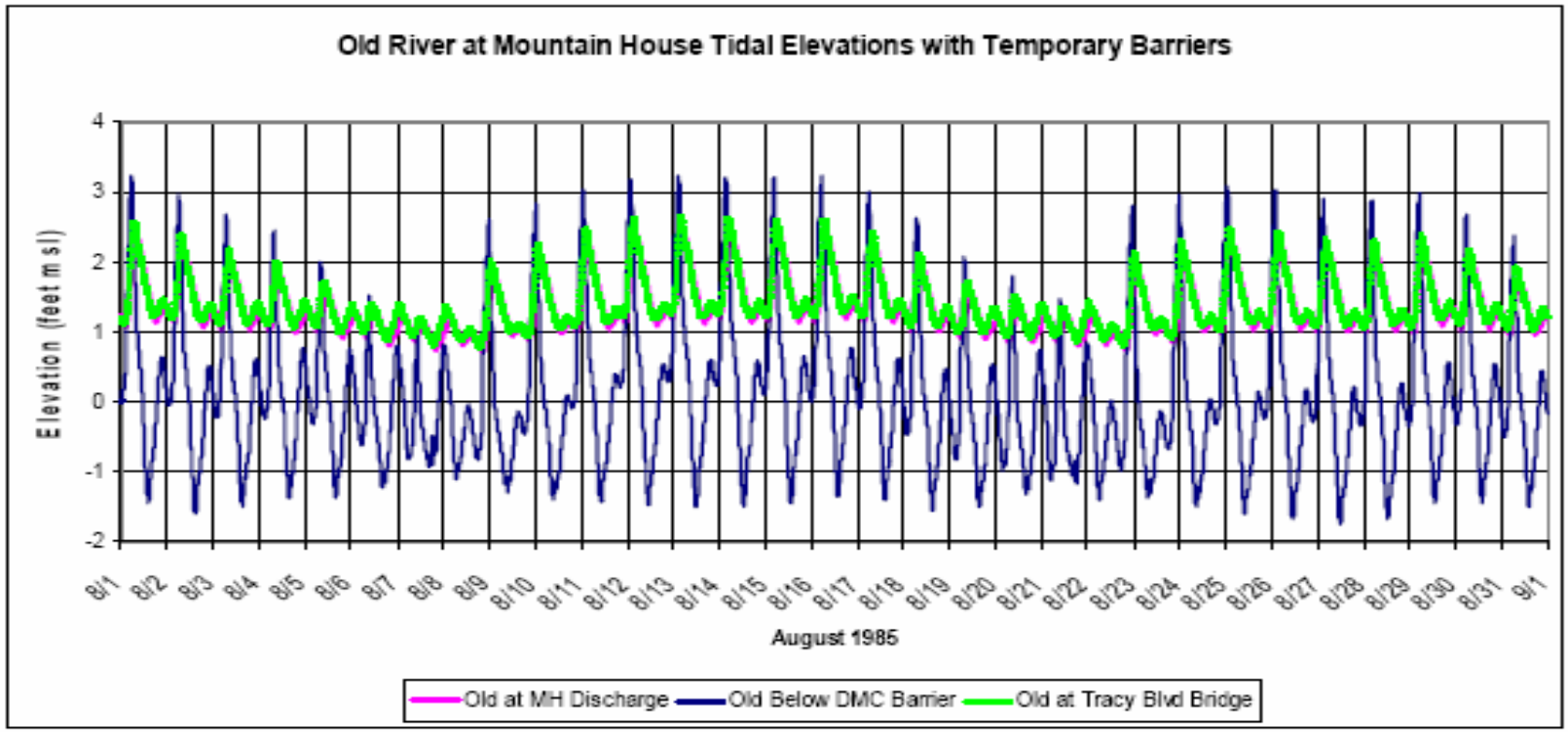

Old River at Tracy Boulevard Bridge
Level (feet msl)
7
6
5
4
3
2
1
0
-1
-2
-3
Oct-76
Oct-77
Oct-78
Oct-79
Oct-80
Oct-81
Oct-82
Oct-83
Oct-84
Oct-85
Oct-86
Oct-87
Oct-88
Oct-89
Oct-90
Oct-91
2001 Base Minimum
2001 Base Median
2001 Base Maximum

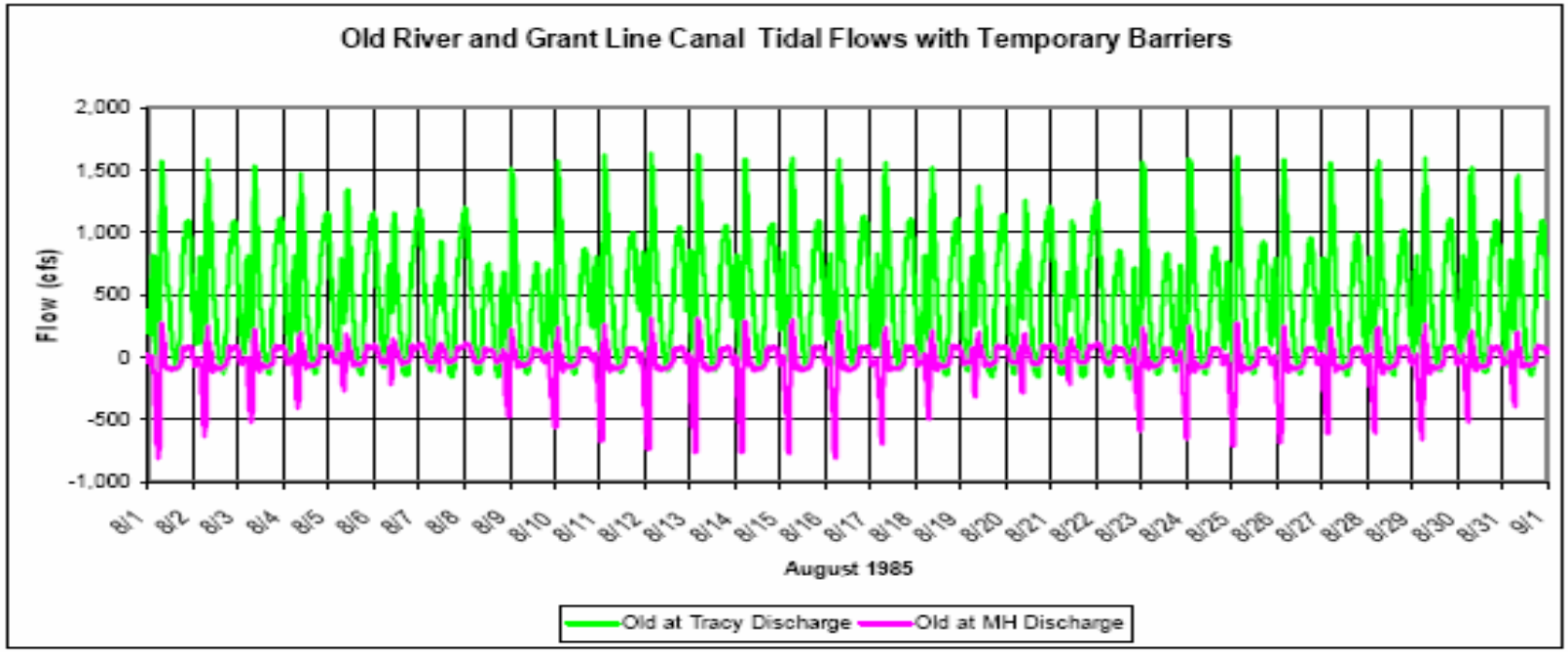

Old River at Tracy Boulevard Bridge
Flow (cfs)
2500
2000
1500
1000
500
0
-500
-1000
Oct-76
Oct-77
Oct-78
Oct-79
Oct-80
Oct-81
Oct-82
Oct-83
Oct-84
Oct-85
Oct-86
Oct-87
Oct-88
Oct-89
Oct-90
Oct-91
2001 Base Minimum
Avg Base 2001
2001 Base Maximum

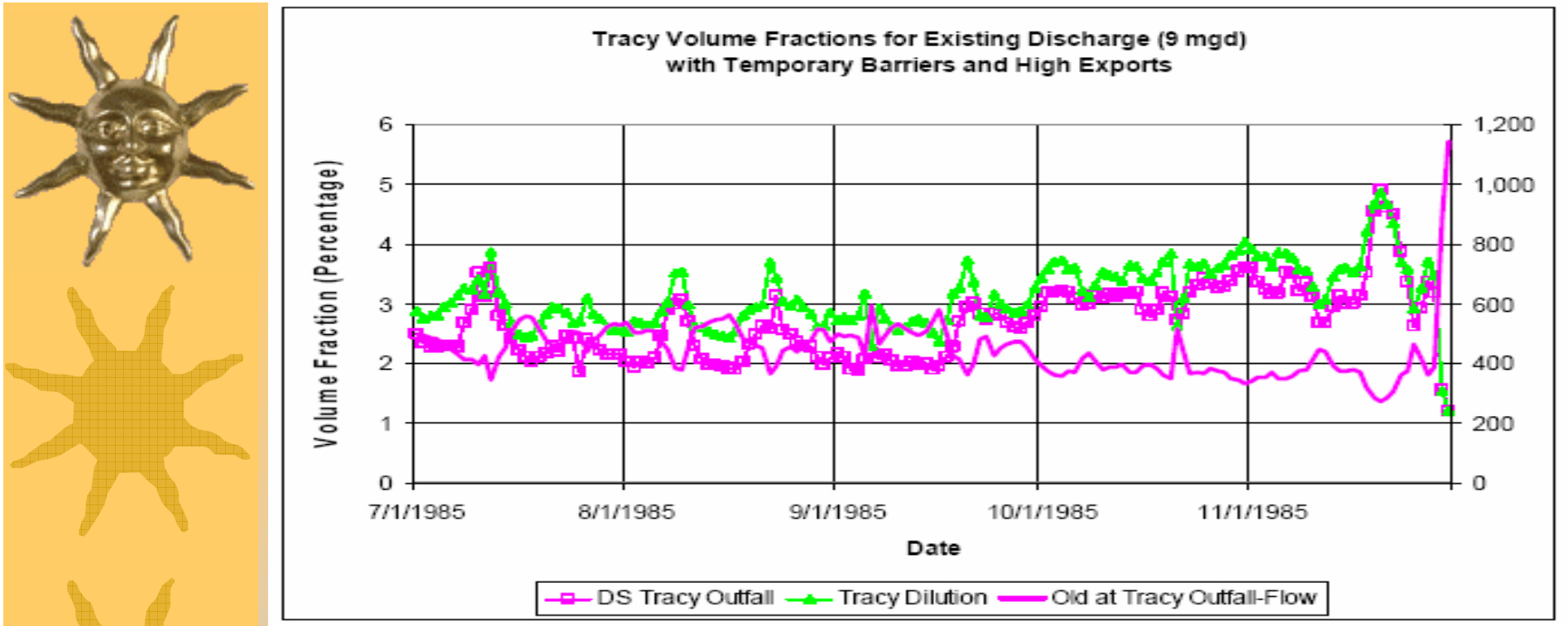

Electrical Conductivity (EC) in Old River at Tracy Boulevard Bridge
EC (uS/cm)
1,250
1,000
750
500
250
0
Oct-76
Oct-77
Oct-78
Oct-79
Oct-80
Oct-81
Oct-82
Oct-83
Oct-84
Oct-85
Oct-86
Oct-87
Oct-88
Oct-89
Oct-90
Oct-91
Avg Base 2001
Vernalis EC
Irrigation EC Objective

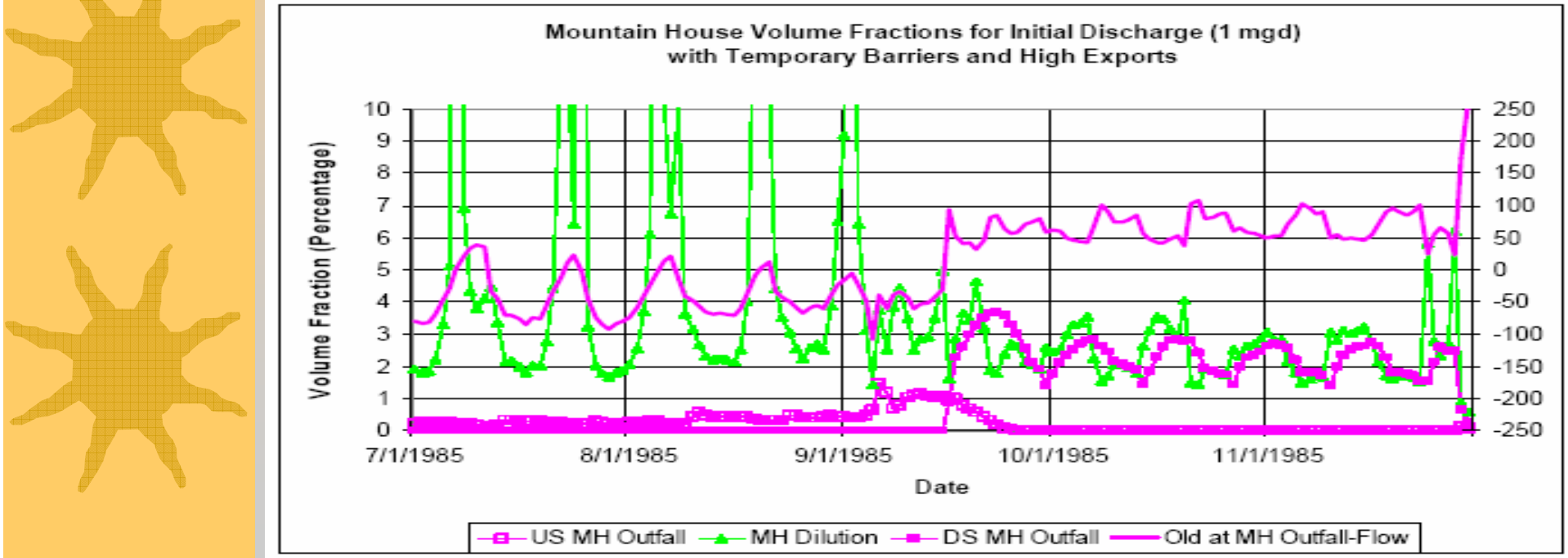

Electrical Conductivity (EC) in Old River at Tracy Boulevard Bridge
Old at Tracy Blvd EC (uS/cm)
1,250
1,000
750
500
250
0
0
250
500
750
1000
1250
Vernalis EC (uS/cm)
EC
No Change
50 uS/cm increase

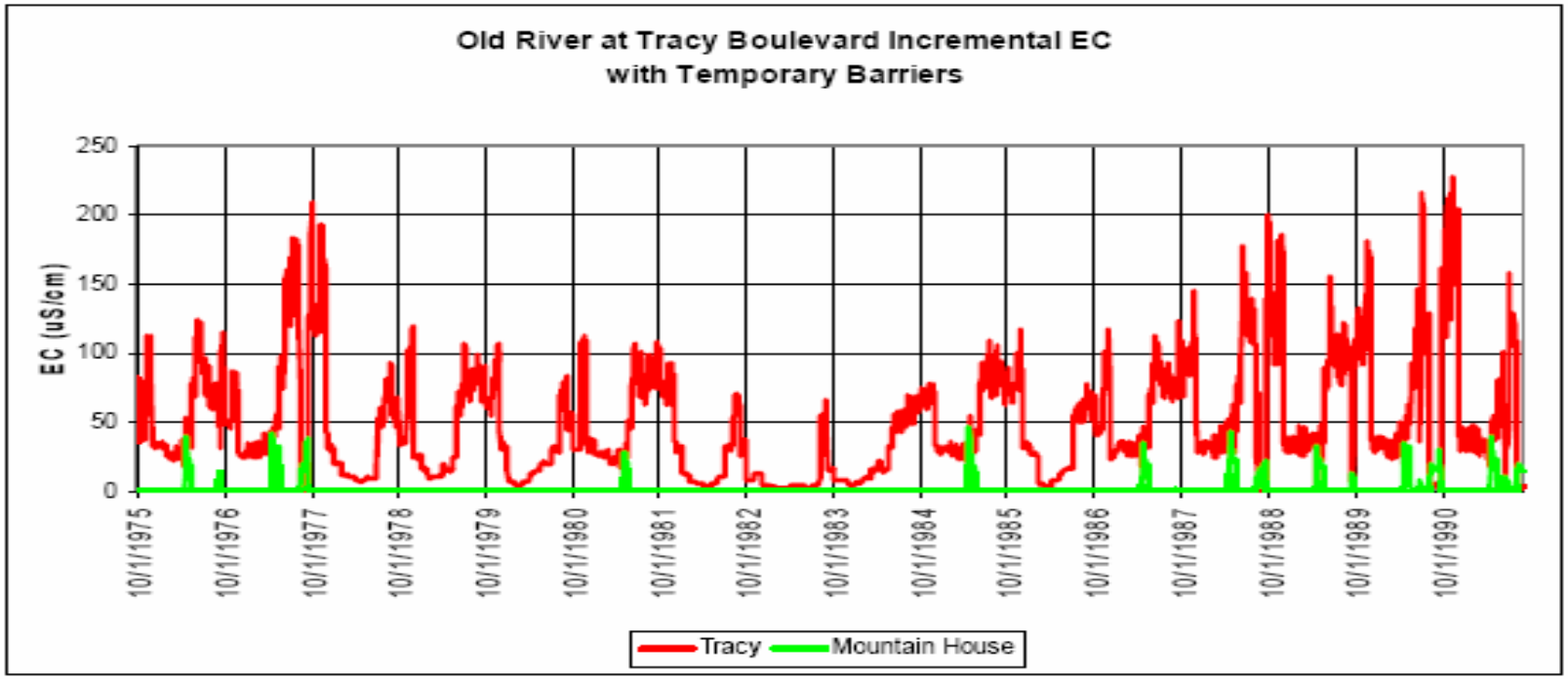


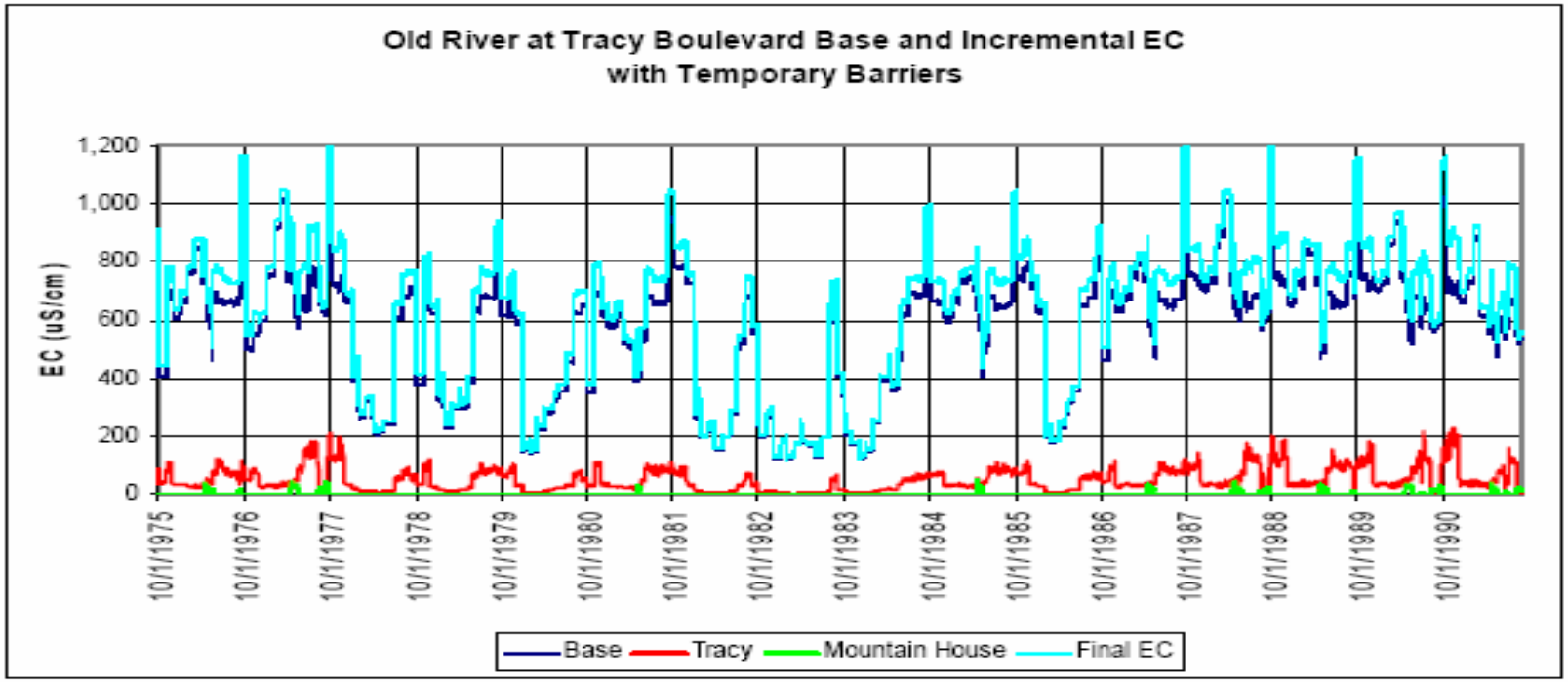

Old River at Mountain House Tidal Elevations with Temporary Barriers
Elevation (feet msl)
4
3
2
1
0
-1
-2
8/1 8/2 8/3 8/4 8/5 8/6 8/7 8/8 8/9 8/10 8/11 8/12 8/13 8/14 8/15 8/16 8/17 8/18 8/19 8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1
August 1985
Old at MH Discharge
Old Below DMC Barrier
Old at Tracy Blvd Bridge

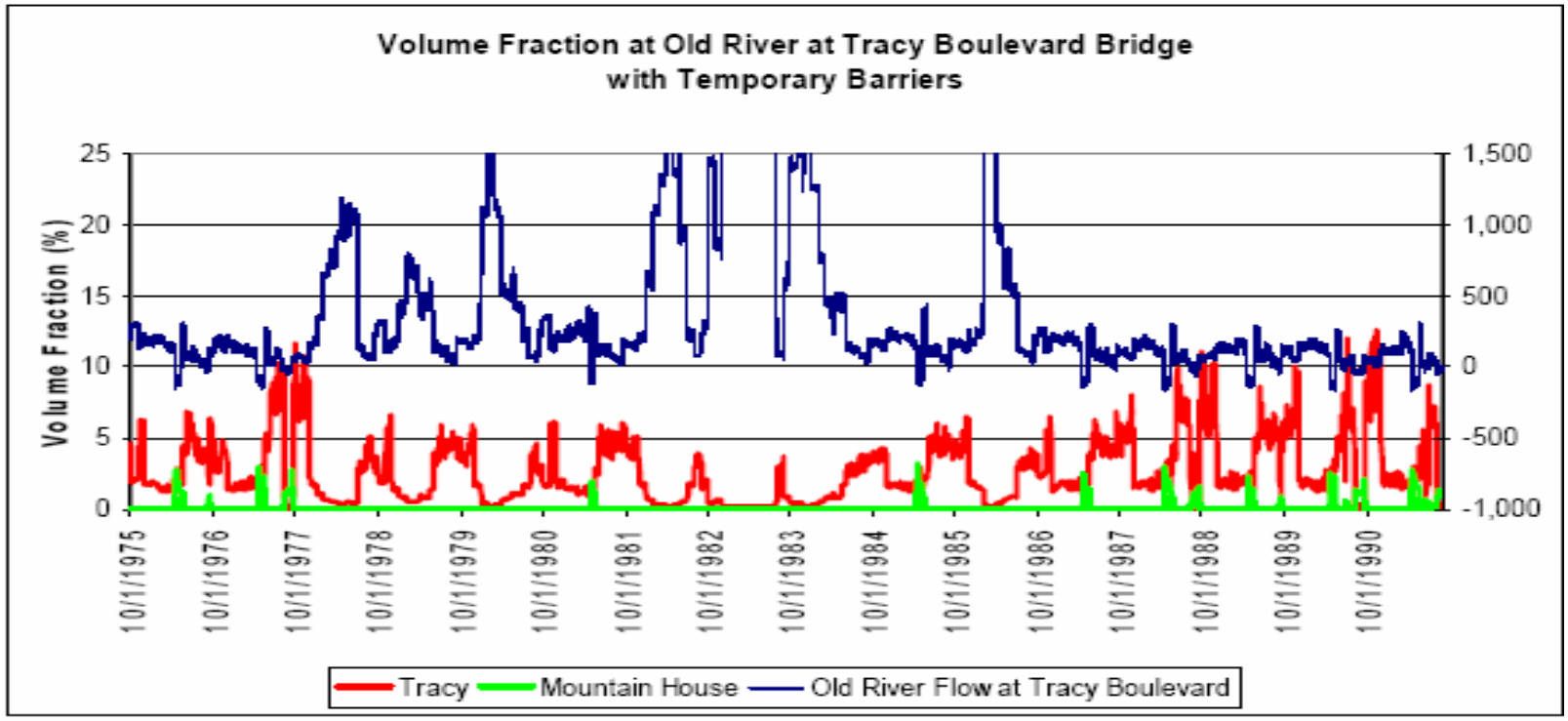

Old River and Grant Line Canal Tidal Flows with Temporary Barriers
Flow (cfs)
2,000
1,500
1,000
500
0
-500
-1,000
8/1 8/2 8/3 8/4 8/5 8/6 8/7 8/8 8/9 8/10 8/11 8/12 8/13 8/14 8/15 8/16 8/17 8/18 8/19 8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1
August 1985
Old at Tracy Discharge
Old at MH Discharge

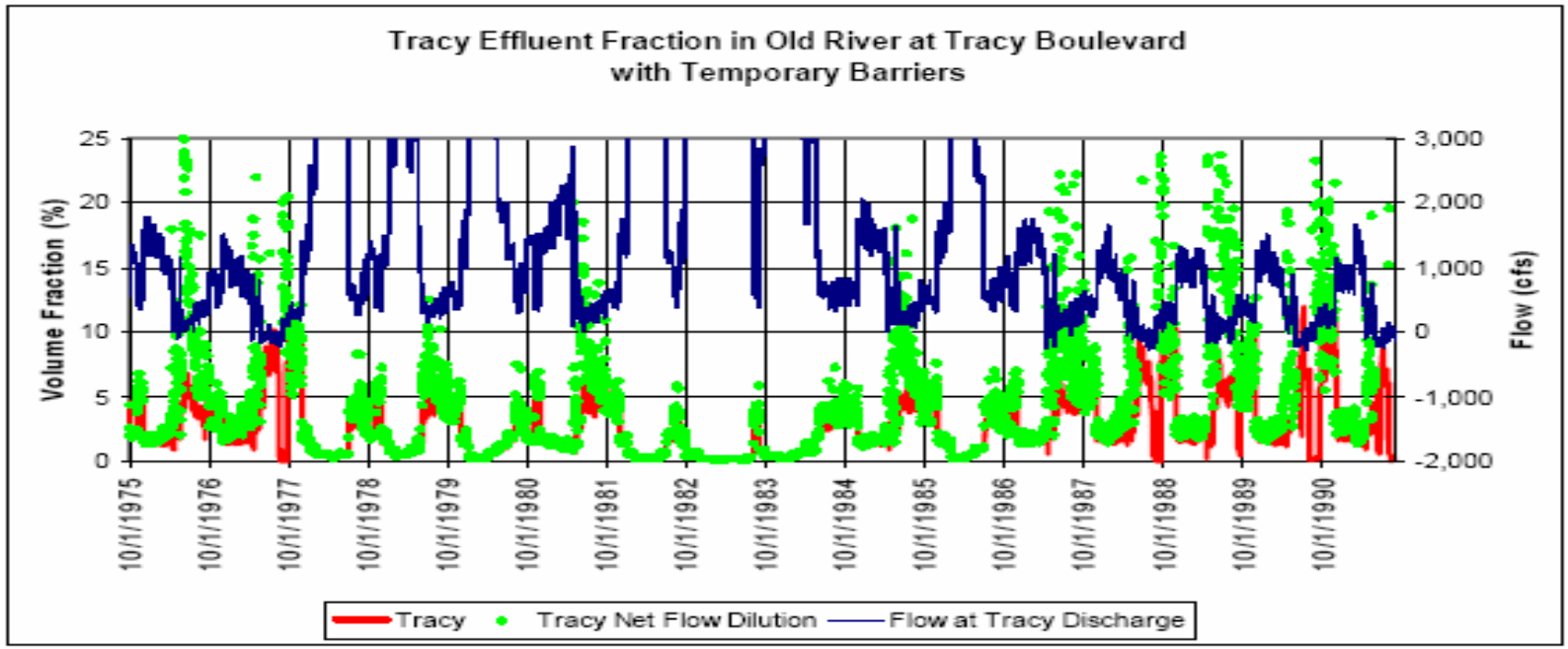

Tracy Volume Fractions for Existing Discharge (9 mgd)
with Temporary Barriers and High Exports
Volume Fraction (Percentage)
0
1
2
3
4
5
6
0
200
400
600
800
1,000
1,200
7/1/1985
8/1/1985
9/1/1985
10/1/1985
11/1/1985
Date
DS Tracy Outfall
Tracy Dilution
Old at Tracy Outfall-Flow

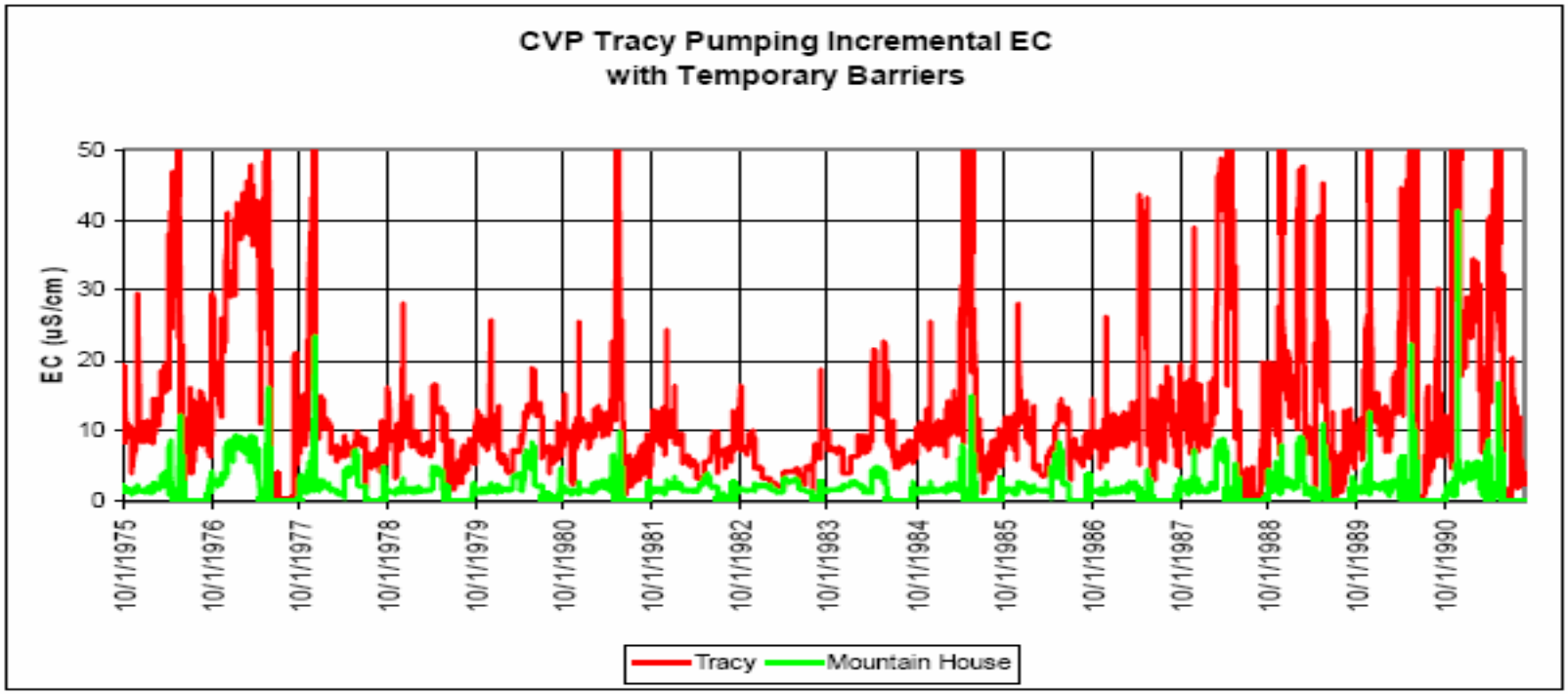

Mountain House Volume Fractions for Initial Discharge (1 mgd)
with Temporary Barriers and High Exports
Volume Fraction (Percentage)
0
1
2
3
4
5
6
7
8
9
10
-250
-200
-150
-100
-50
0
50
100
150
200
250
7/1/1985
8/1/1985
9/1/1985
10/1/1985
11/1/1985
Date
US MH Outfall
MH Dilution
DS MH Outfall
Old at MH Outfall-Flow

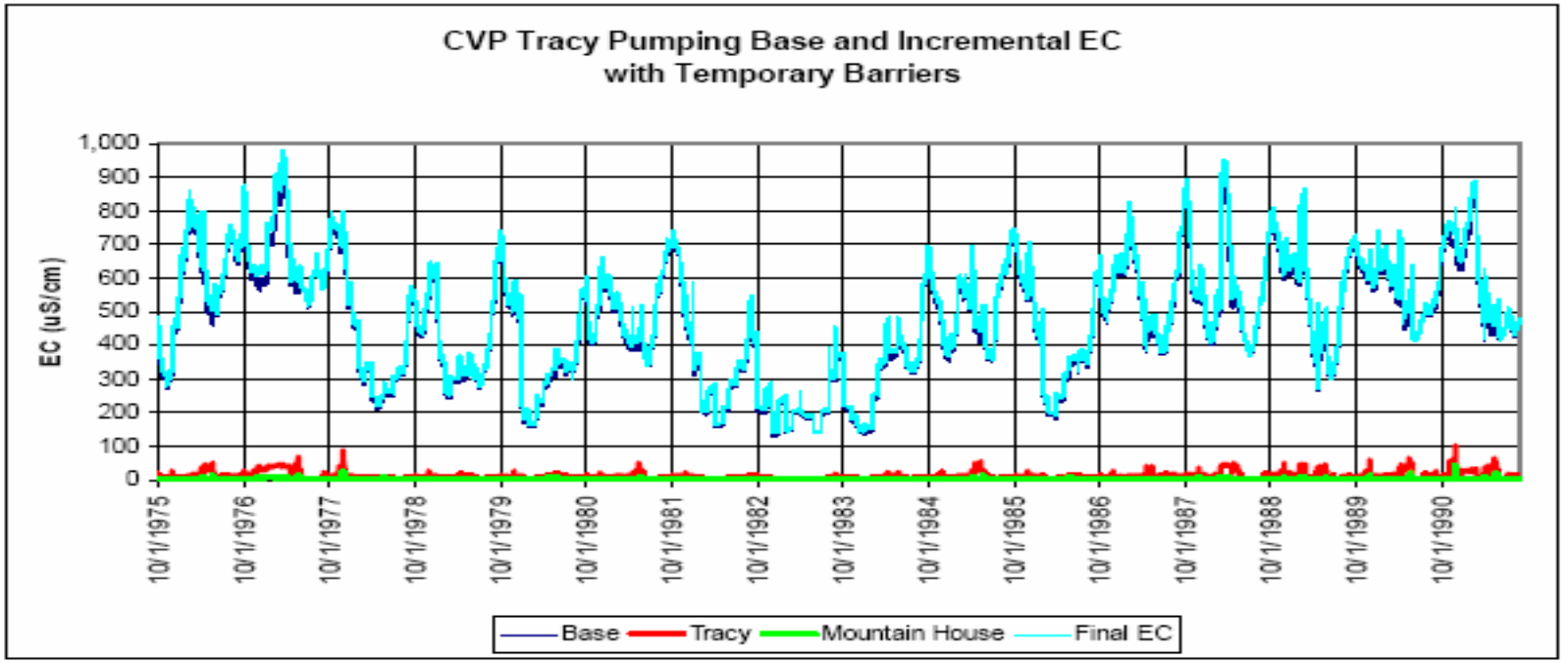

Old River at Tracy Boulevard Incremental EC
with Temporary Barriers
EC (uS/cm)
250
200
150
100
50
0
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House

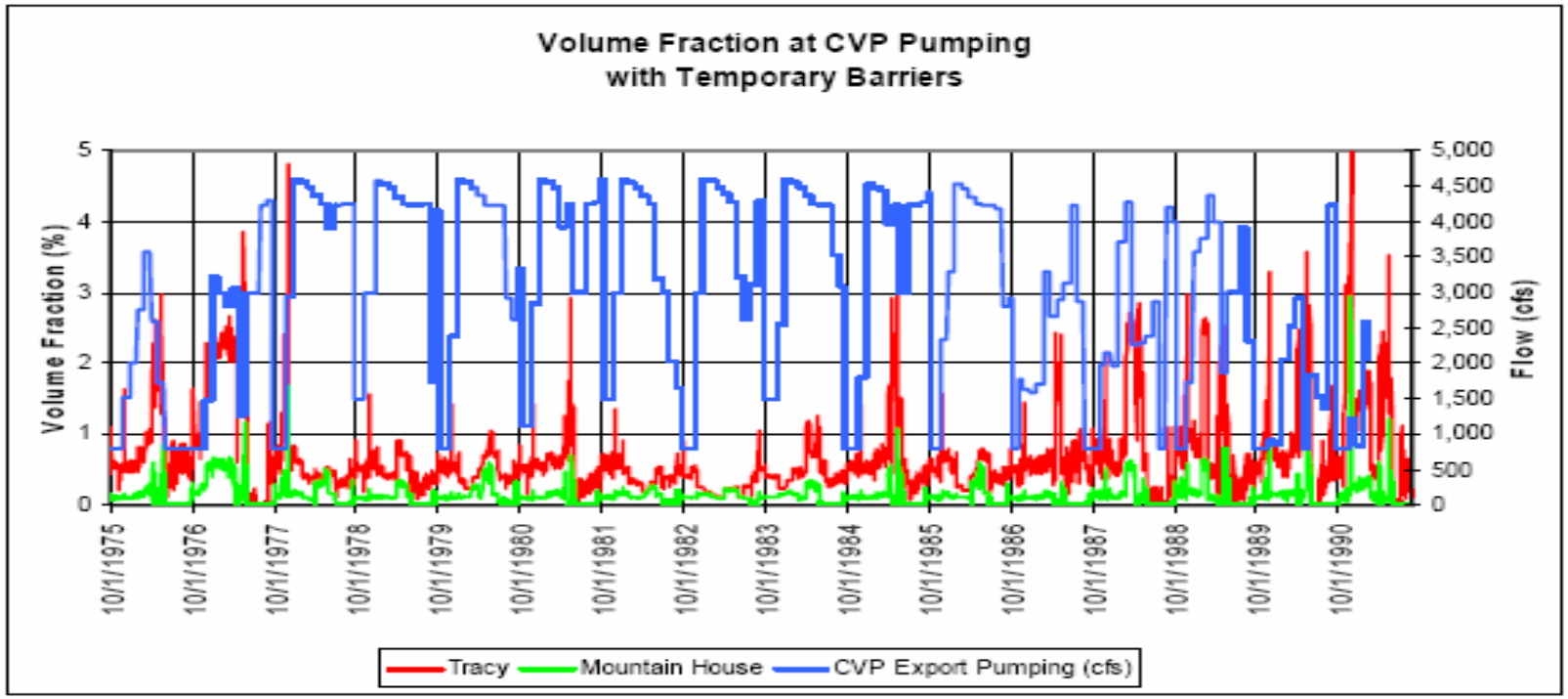

Old River at Tracy Boulevard Base and Incremental EC
with Temporary Barriers
EC (uS/cm)
1,200
1,000
800
600
400
200
0
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Base
Tracy
Mountain House
Final EC

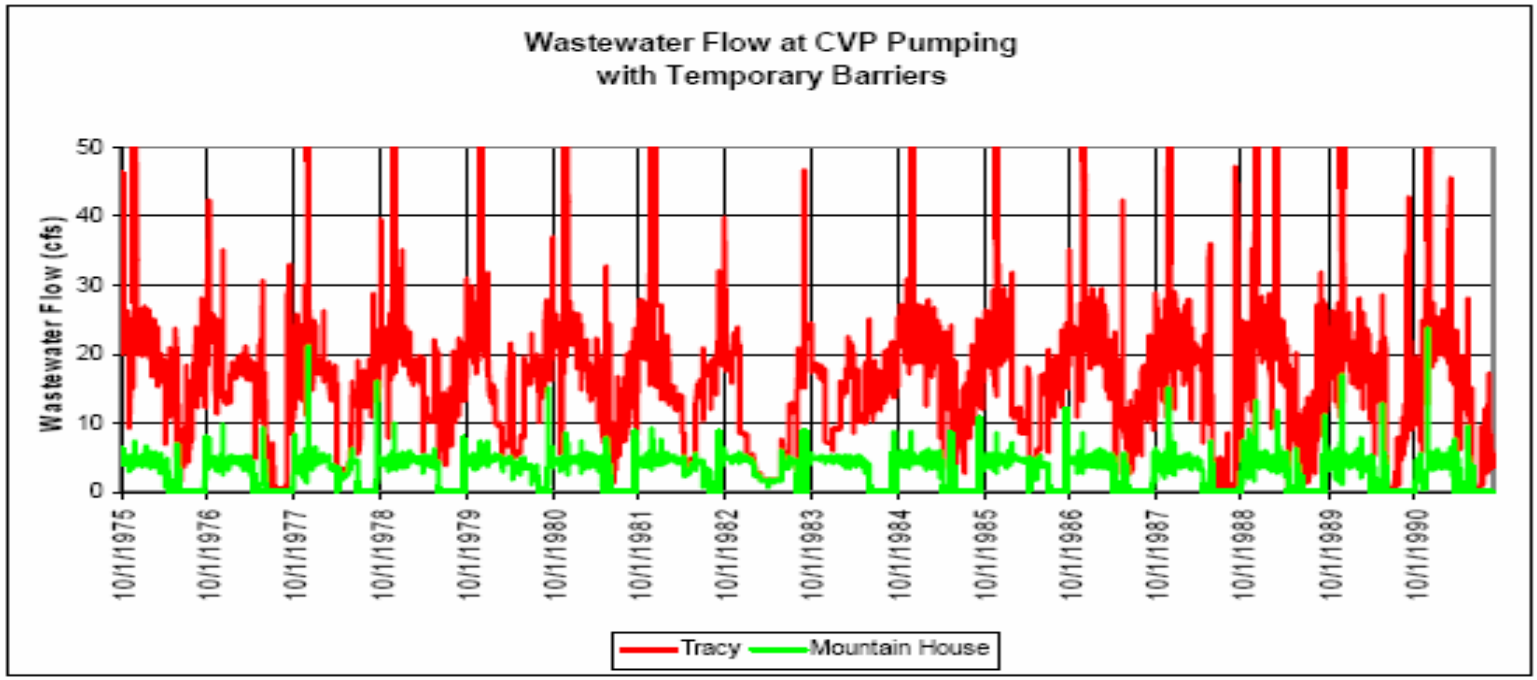

Volume Fraction at Old River at Tracy Boulevard Bridge
with Temporary Barriers
Volume Fraction (%)
25
20
15
10
5
0
1,500
1,000
500
0
-500
-1,000
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House
Old River Flow at Tracy Boulevard


Tracy Effluent Fraction in Old River at Tracy Boulevard
with Temporary Barriers
Volume Fraction (%)
25
20
15
10
5
0
3,000
2,000
1,000
0
-1,000
-2,000
Flow (cfs)
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Tracy Net Flow Dilution
Flow at Tracy Discharge


CVP Tracy Pumping Incremental EC
with Temporary Barriers
EC (uS/cm)
50
40
30
20
10
0
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House

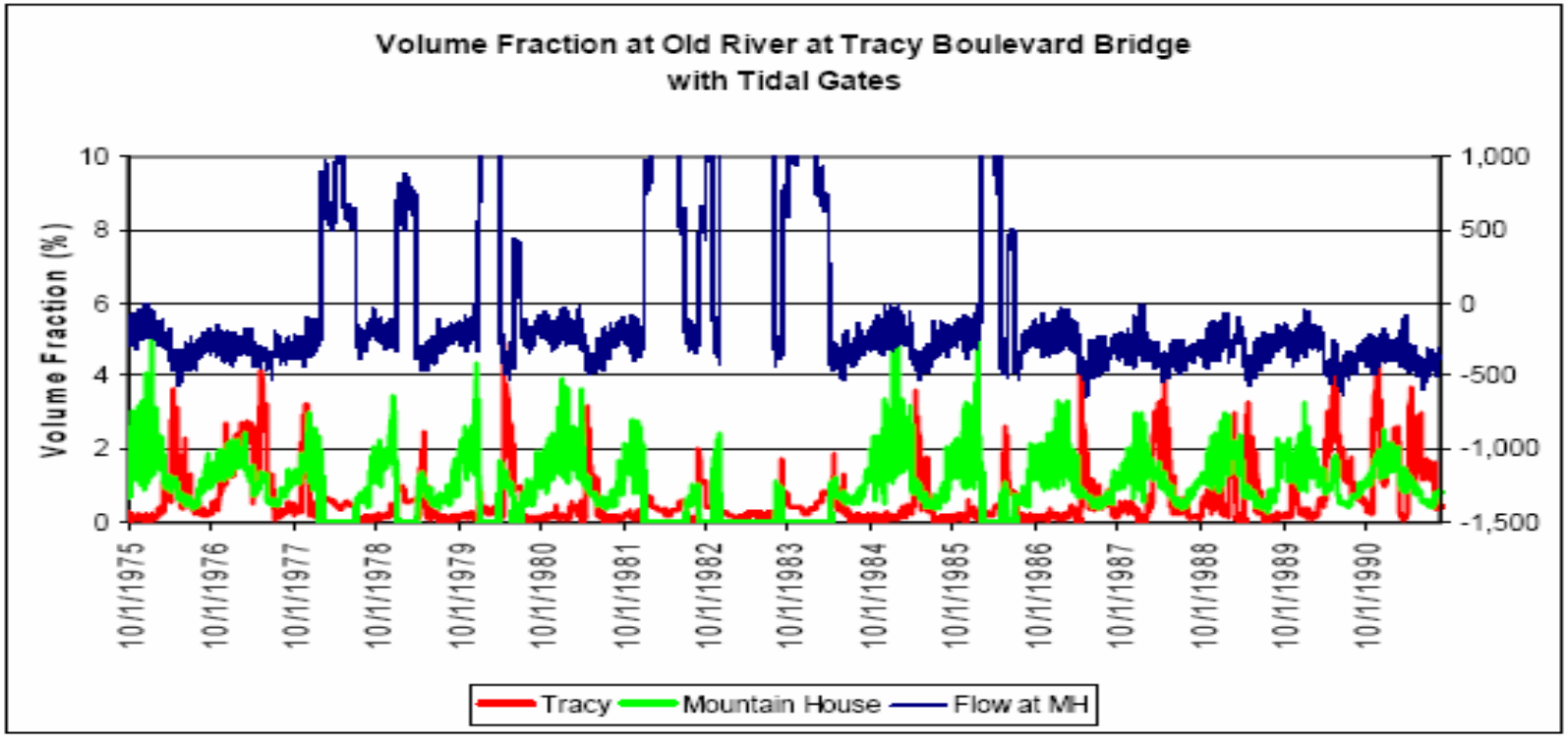

CVP Tracy Pumping Base and Incremental EC
with Temporary Barriers
EC (uS/cm)
1,000
900
800
700
600
500
400
300
200
100
0
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Base
Tracy
Mountain House
Final EC

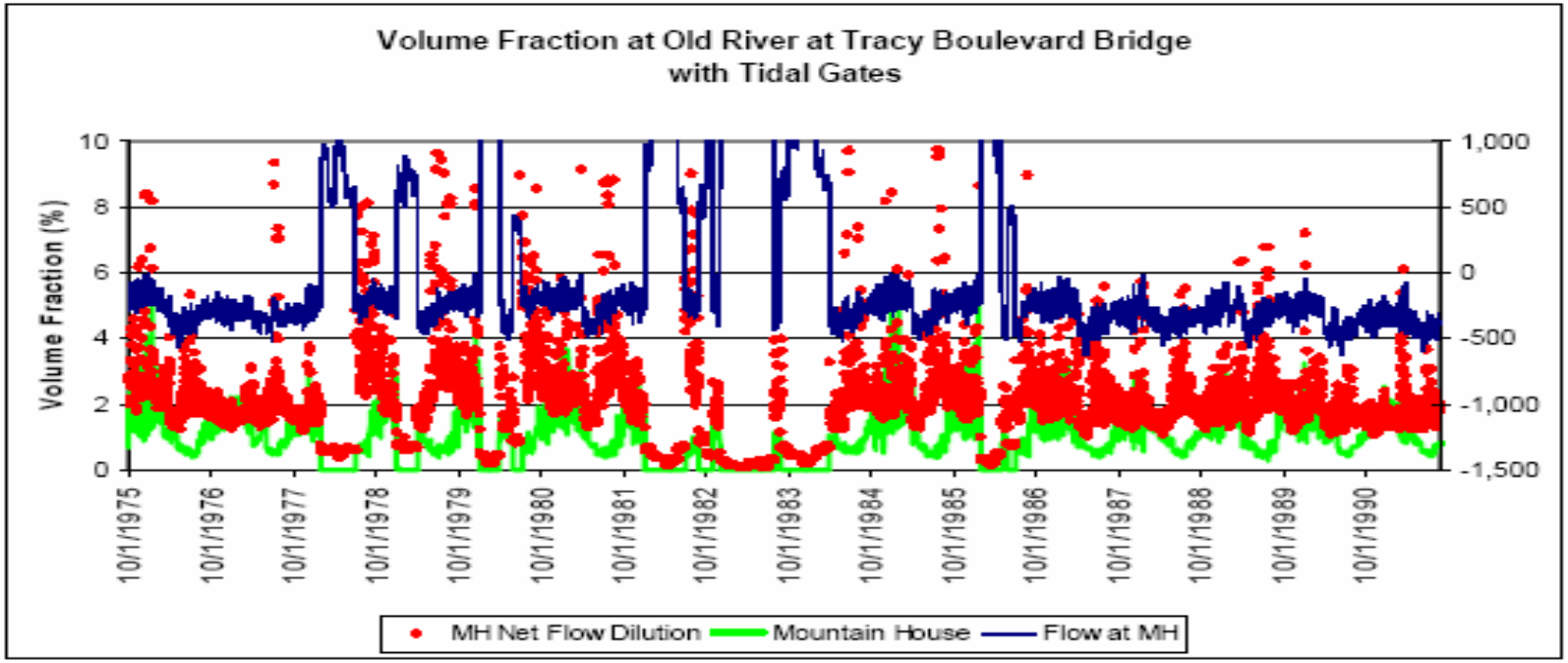

Volume Fraction at CVP Pumping
with Temporary Barriers
Volume Fraction (%)
Flow (cfs)
0
1
2
3
4
5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House
CVP Export Pumping (cfs)

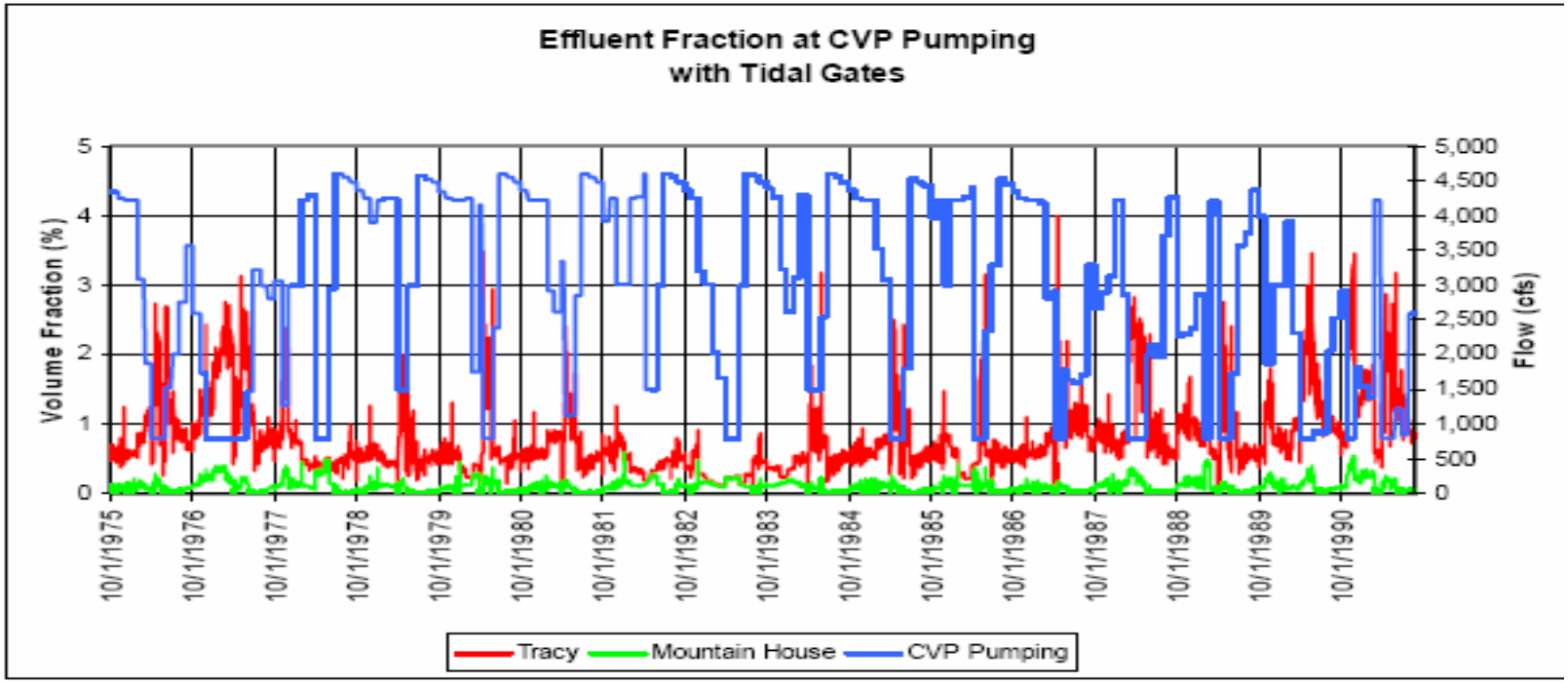

Wastewater Flow at CVP Pumping
with Temporary Barriers
Wastewater Flow (cfs)
0
10
20
30
40
50
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House

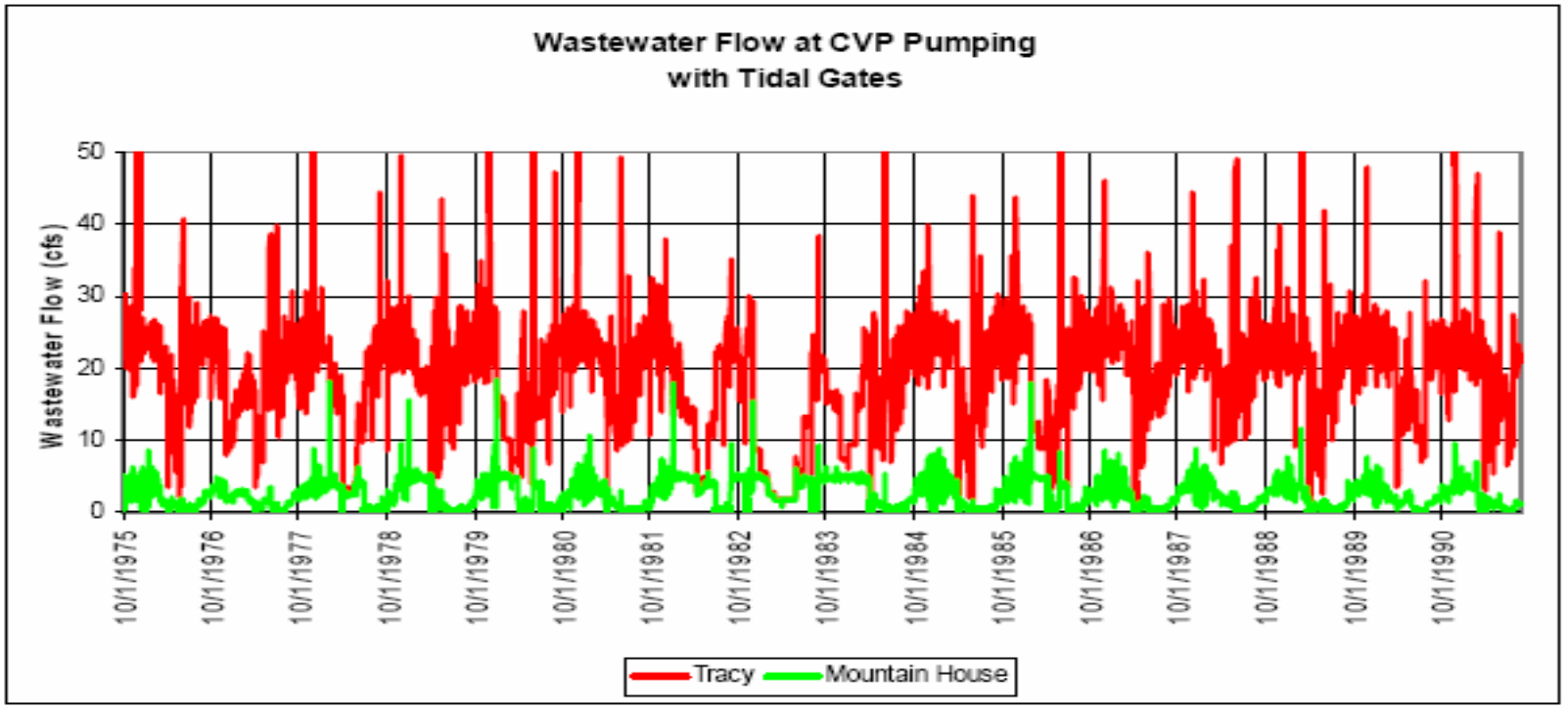
South Delta Tidal Gates

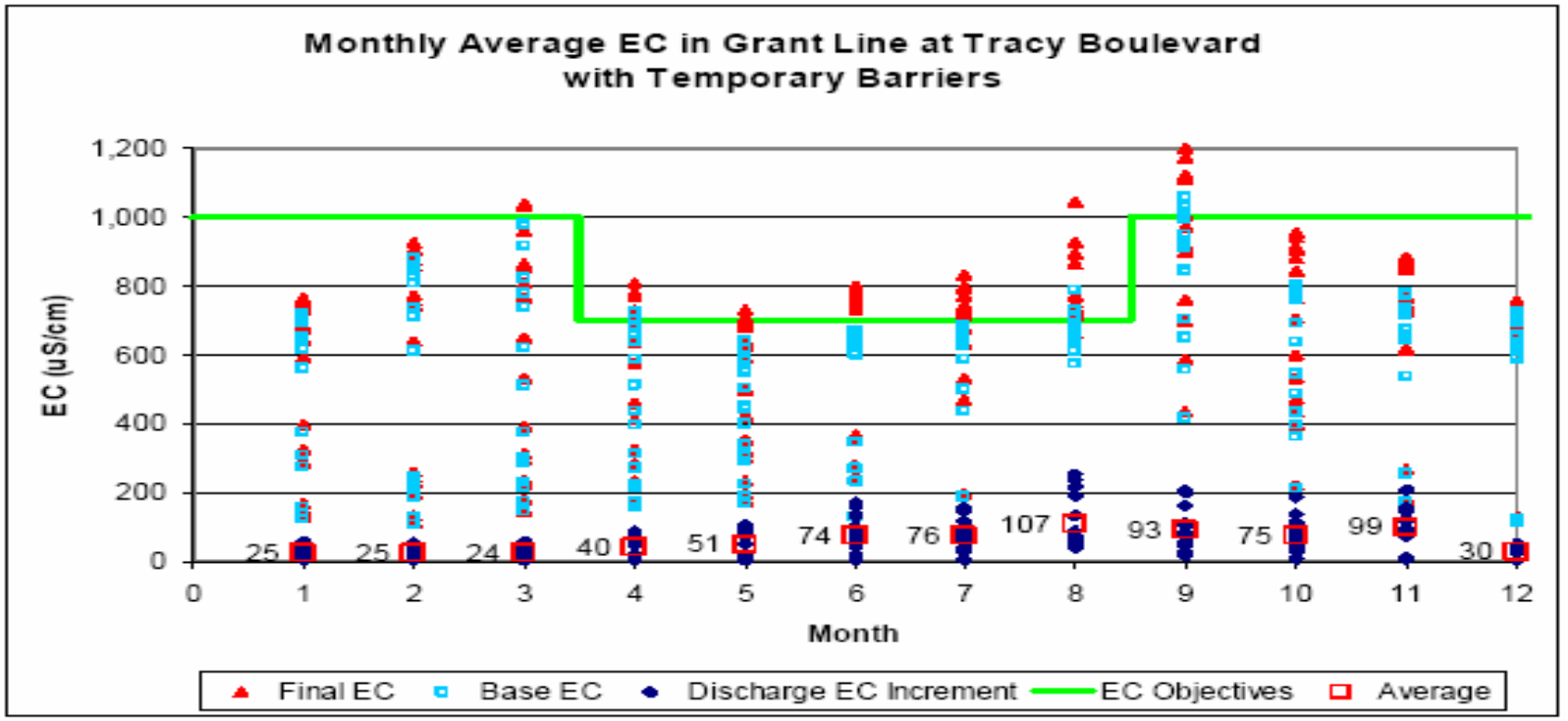
- SDIP head of Old River gate operations should provide a minimum flow past Tracy
- Old River at DMC and Middle River gates will provide a minimum upstream tidal pumping flow during irrigation season
- CVP and SWP export pumping will provide similar large dilution of wastewater flow with or without gates

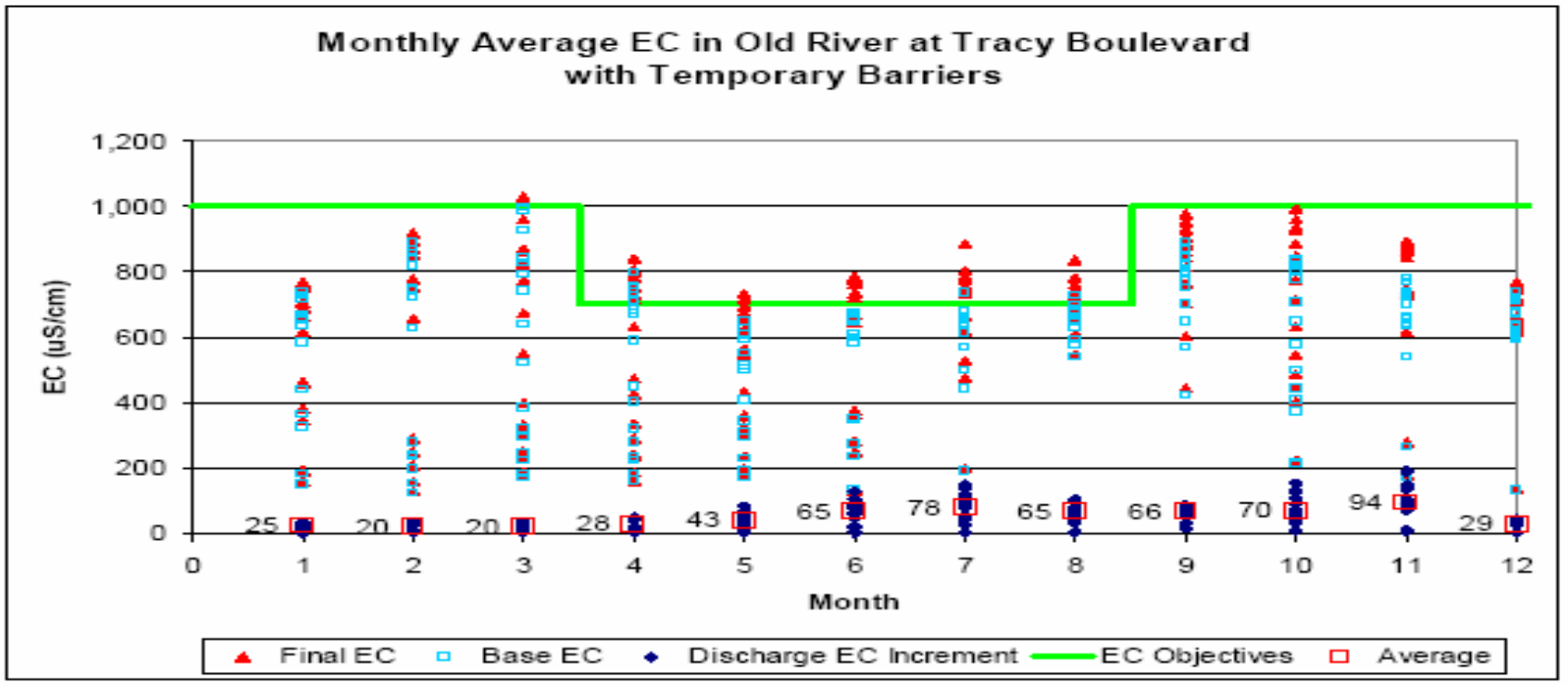

Volume Fraction at Old River at Tracy Boulevard Bridge
with Tidal Gates
Volume Fraction (%)
10
8
6
4
2
0
1,000
500
0
-500
-1,000
-1,500
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House
Flow at MH

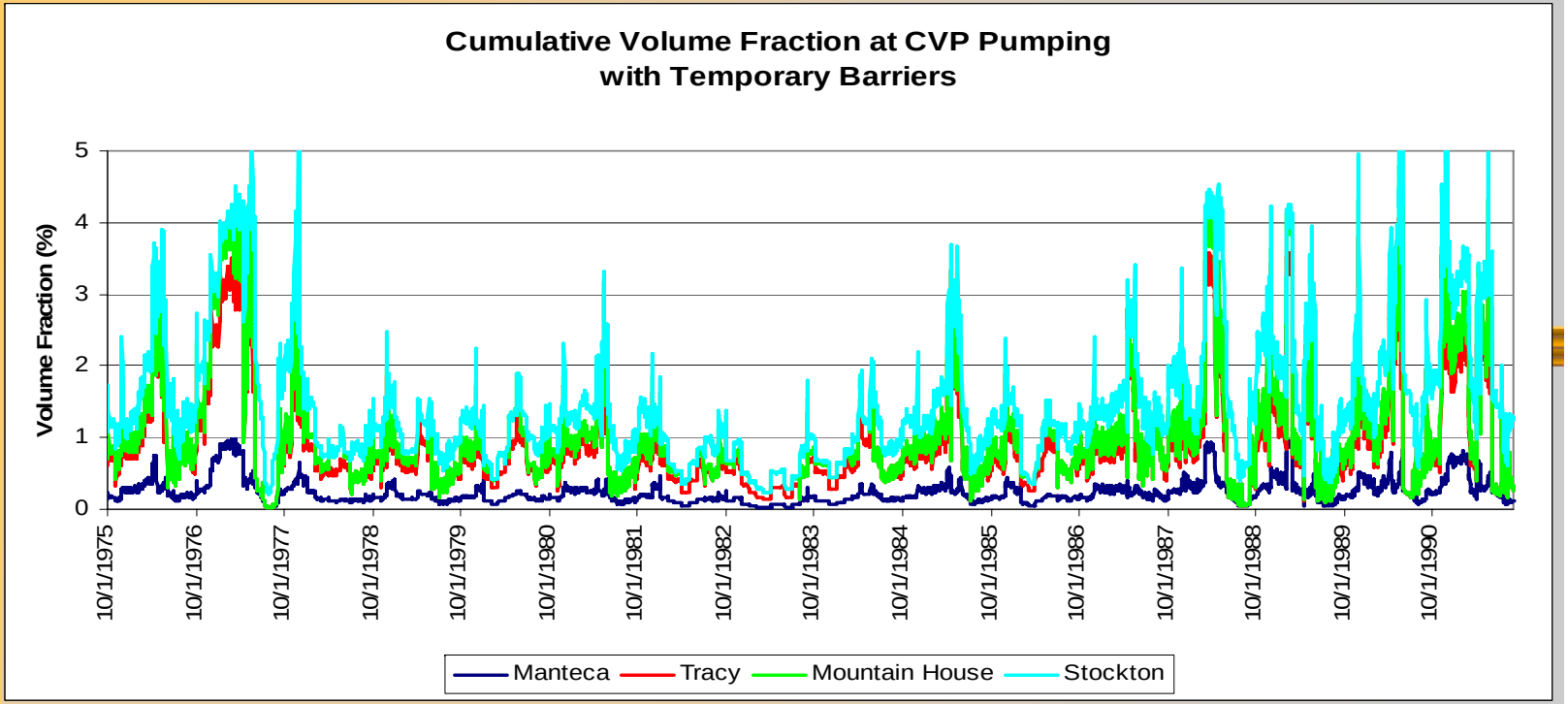

Volume Fraction at Old River at Tracy Boulevard Bridge
with Tidal Gates
Volume Fraction (%)
10
8
6
4
2
0
1,000
500
0
-500
-1,000
-1,500
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
MH Net Flow Dilution
Mountain House
Flow at MH

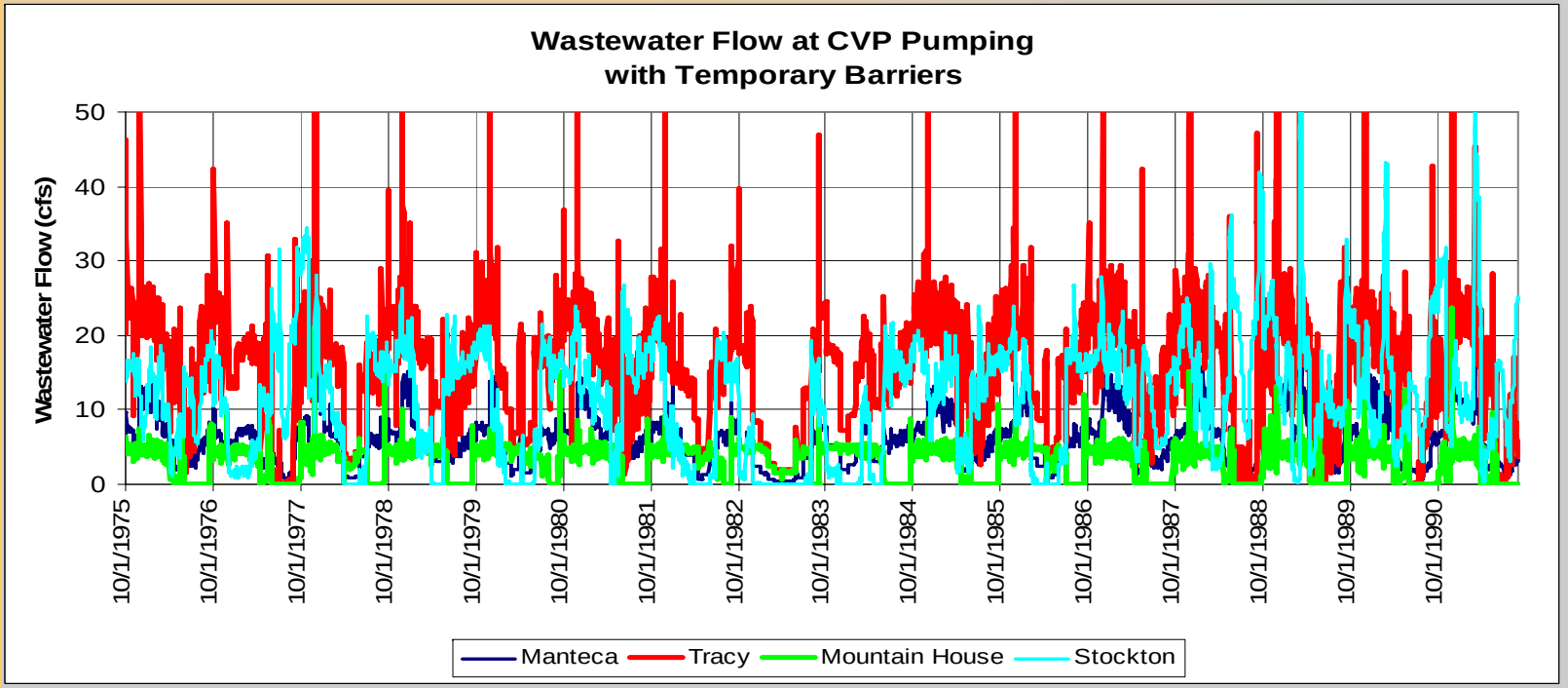

Effluent Fraction at CVP Pumping
with Tidal Gates
Volume Fraction (%)
Flow (cfs)
0
1
2
3
4
5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House
CVP Pumping


Wastewater Flow at CVP Pumping
with Tidal Gates
Wastewater Flow (cfs)
0
10
20
30
40
50
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Tracy
Mountain House


Monthly Average EC in Grant Line at Tracy Boulevard
with Temporary Barriers
EC (uS/cm)
1,200
1,000
800
600
400
200
0
25
25
24
40
51
74
76
107
93
75
99
30
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
Final EC
Base EC
Discharge EC Increment
EC Objectives
Average


Monthly Average EC in Old River at Tracy Boulevard
with Temporary Barriers
EC (uS/cm)
1,200
1,000
800
600
400
200
0
25
20
20
28
43
65
78
65
66
70
94
29
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
Final EC
Base EC
Discharge EC Increment
EC Objectives
Average


Cumulative Volume Fraction at CVP Pumping
with Temporary Barriers
Volume Fraction (%)
0
1
2
3
4
5
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Manteca
Tracy
Mountain House
Stockton

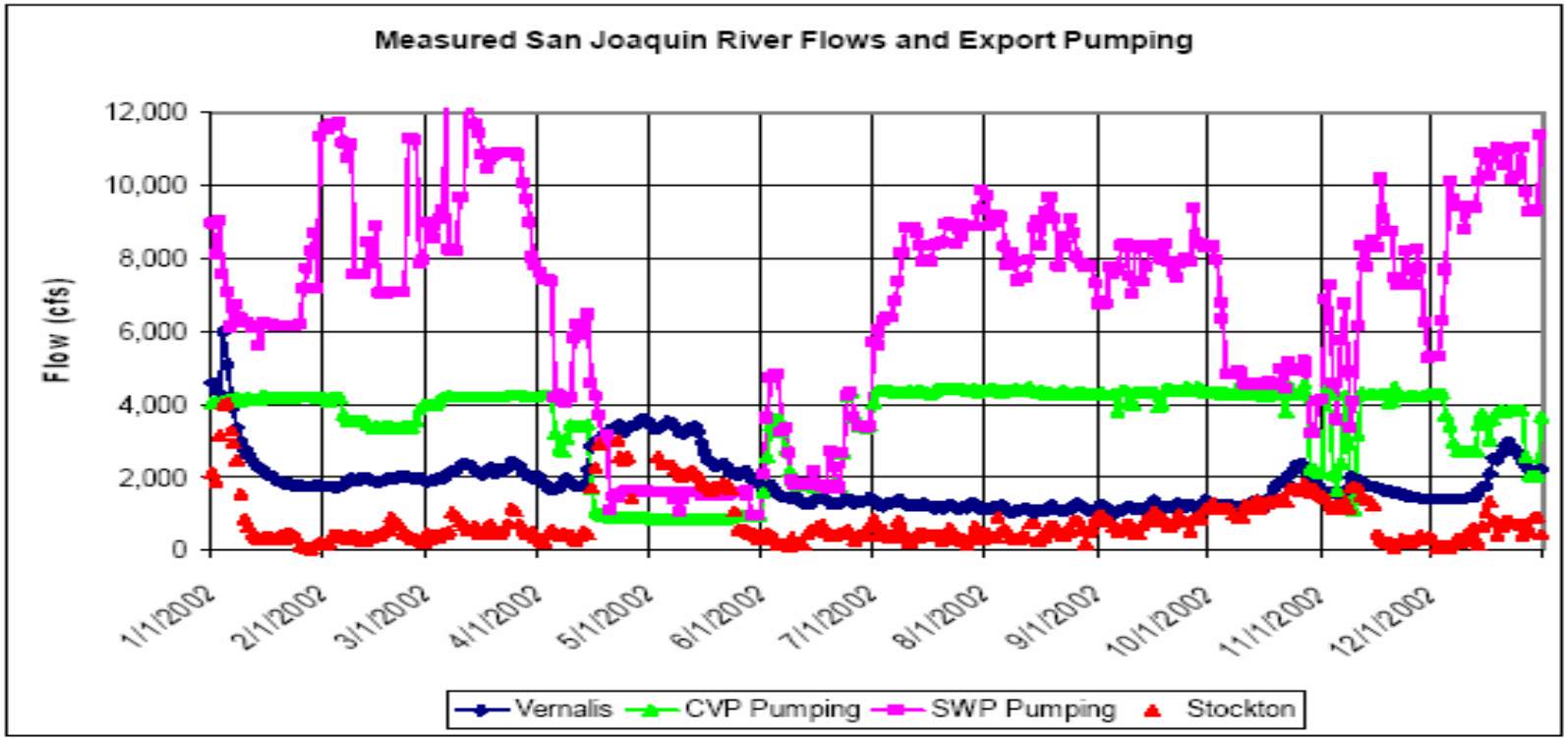

Wastewater Flow at CVP Pumping
with Temporary Barriers
Wastewater Flow (cfs)
0
10
20
30
40
50
10/1/1975
10/1/1976
10/1/1977
10/1/1978
10/1/1979
10/1/1980
10/1/1981
10/1/1982
10/1/1983
10/1/1984
10/1/1985
10/1/1986
10/1/1987
10/1/1988
10/1/1989
10/1/1990
Manteca
Tracy
Mountain House
Stockton

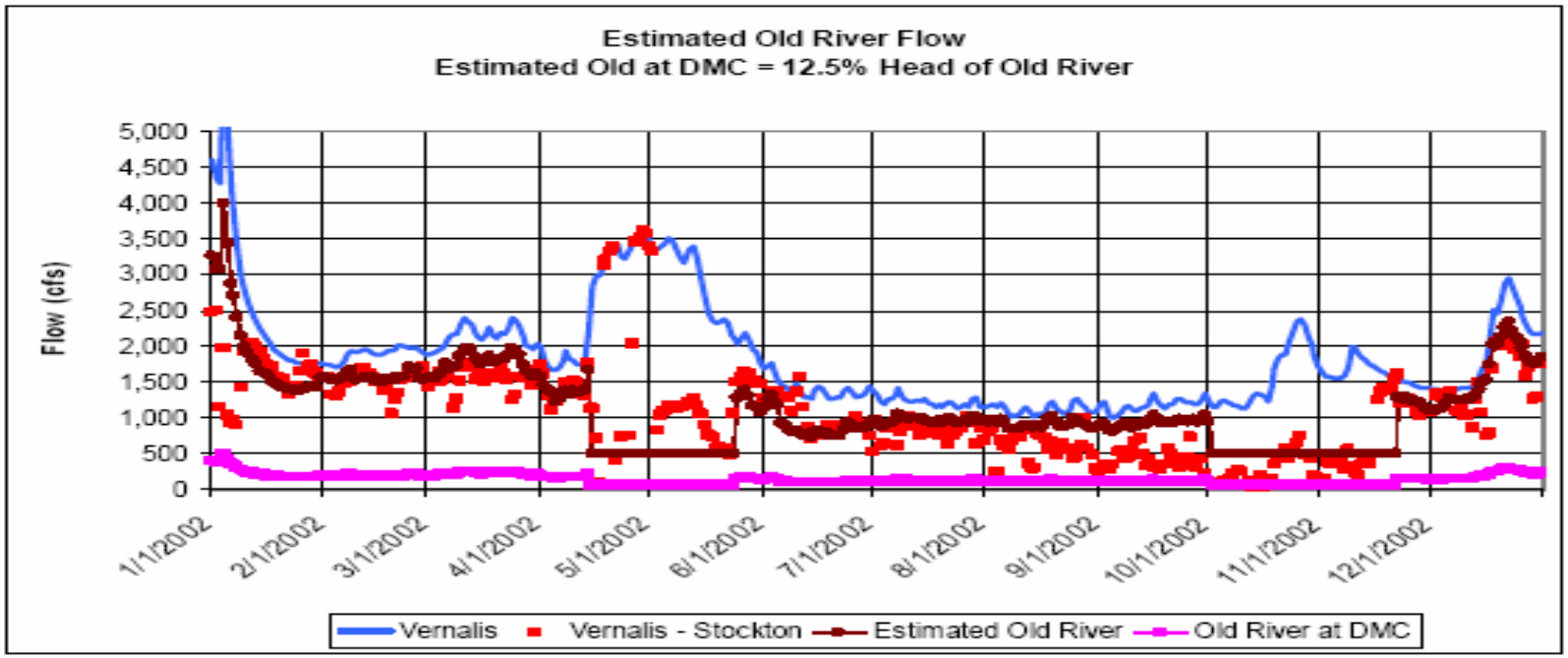
DSM2 Salinity Simulation

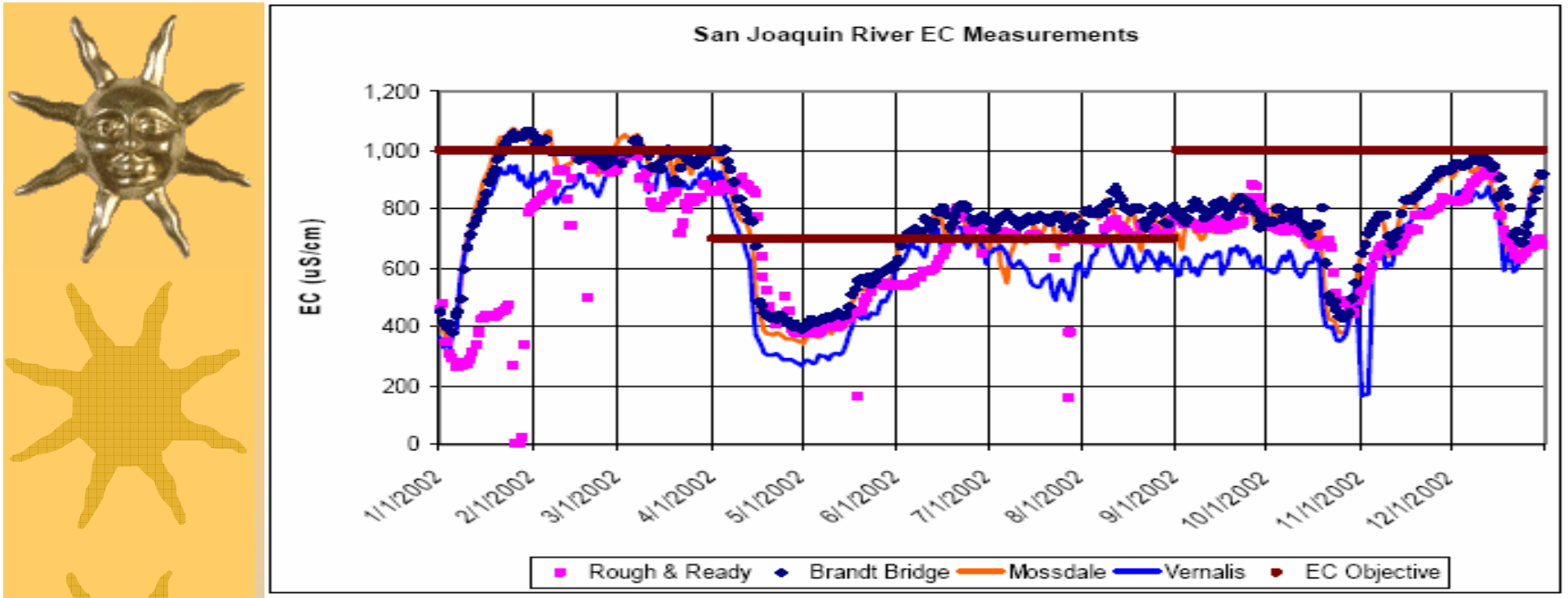
- Range of flows (years) can be simulated
- San Joaquin River Vernalis EC?
- Agricultural diversion and drainage?
- Tidal flows with barriers or gates?
- Wastewater effluent EC?
- DSM2 daily average volume fraction = discharge/(Daily net flow + discharge)

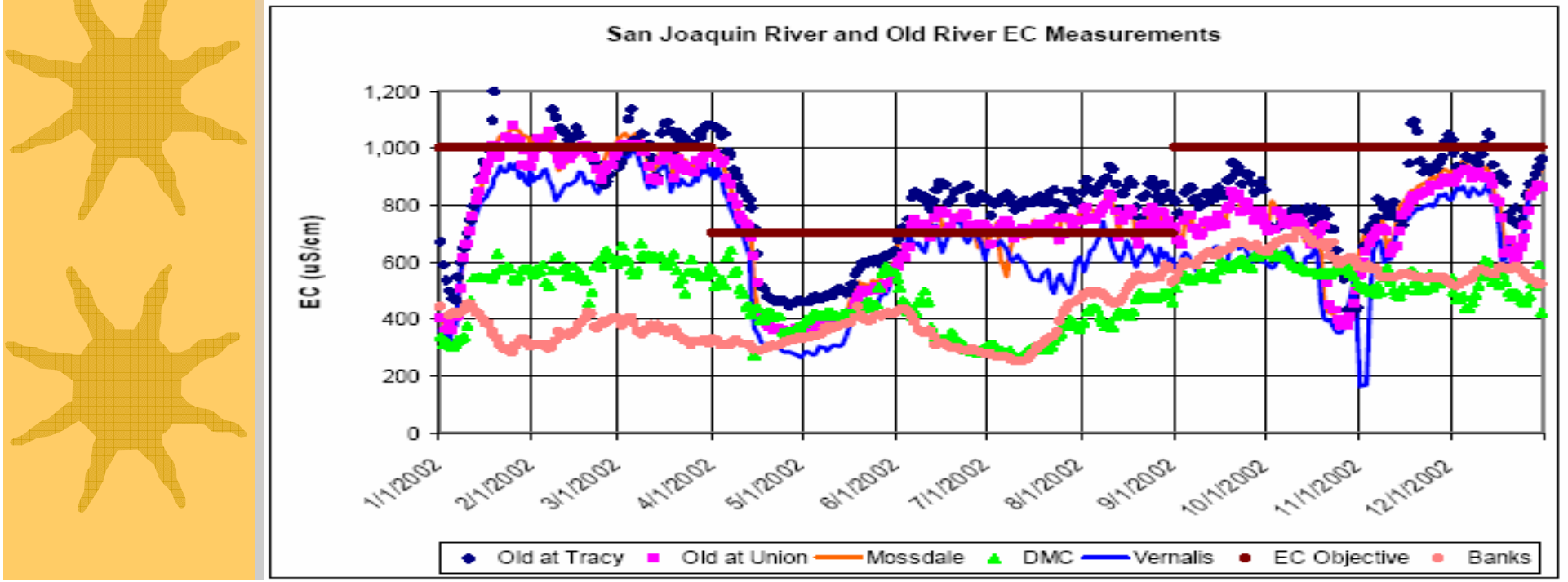
Historical Flow and EC Data

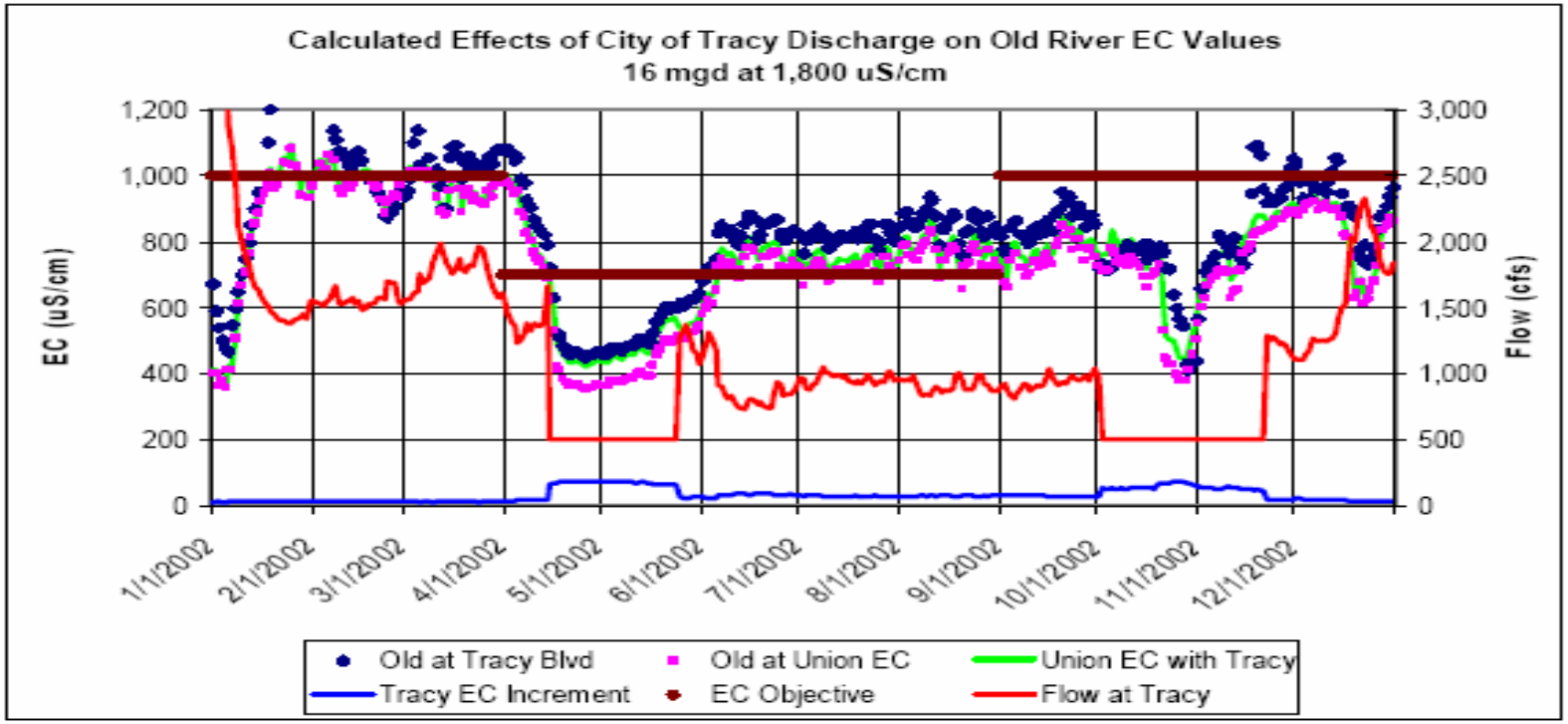
- Measured flows & EC from recent years
- Wastewater or agricultural effects can be estimated as increment from historical EC
- Alternatives for wastewater and agricultural salinity controls can be evaluated more easily and rapidly
- Future net flows with barriers and gates are uncertain

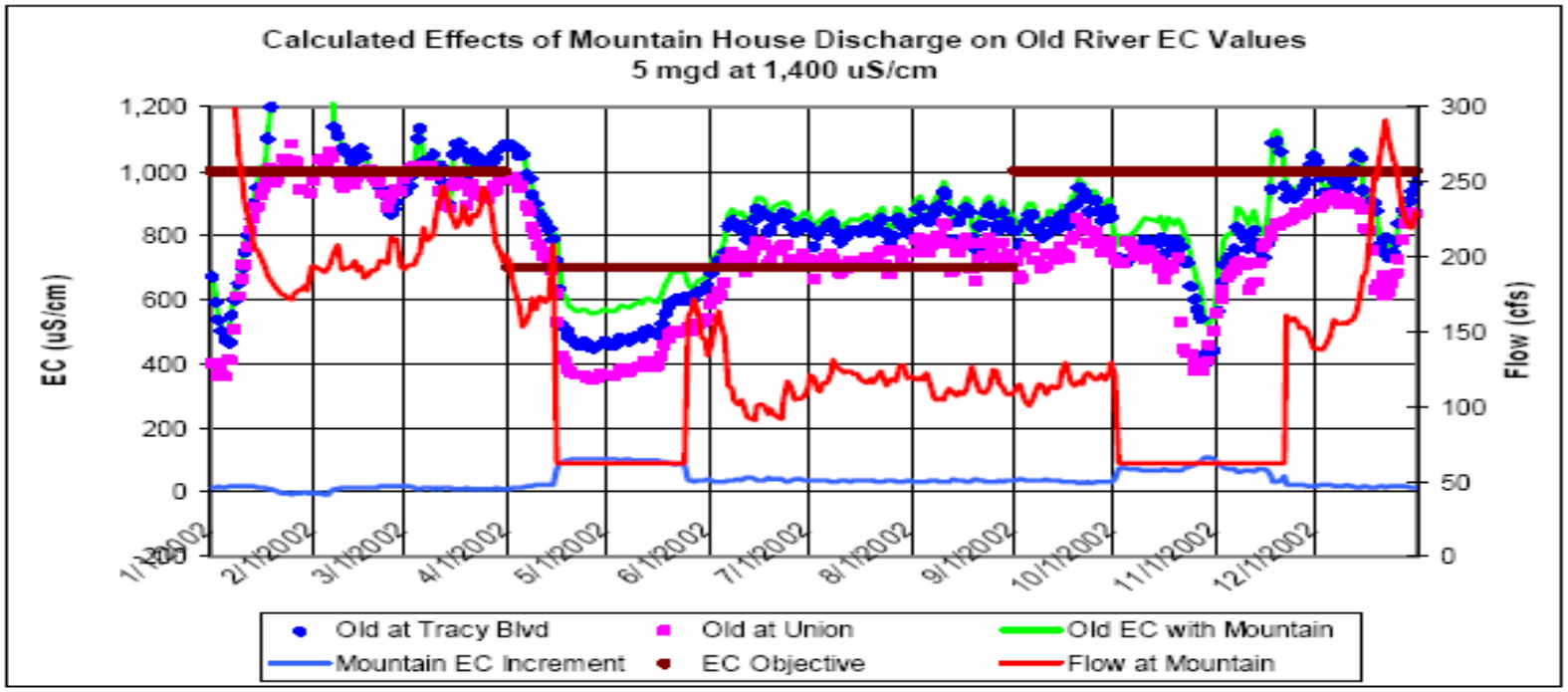

Measured San Joaquin River Flows and Export Pumping
Flow (cfs)
12,000
10,000
8,000
6,000
4,000
2,000
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Vernalis
CVP Pumping
SWP Pumping
Stockton

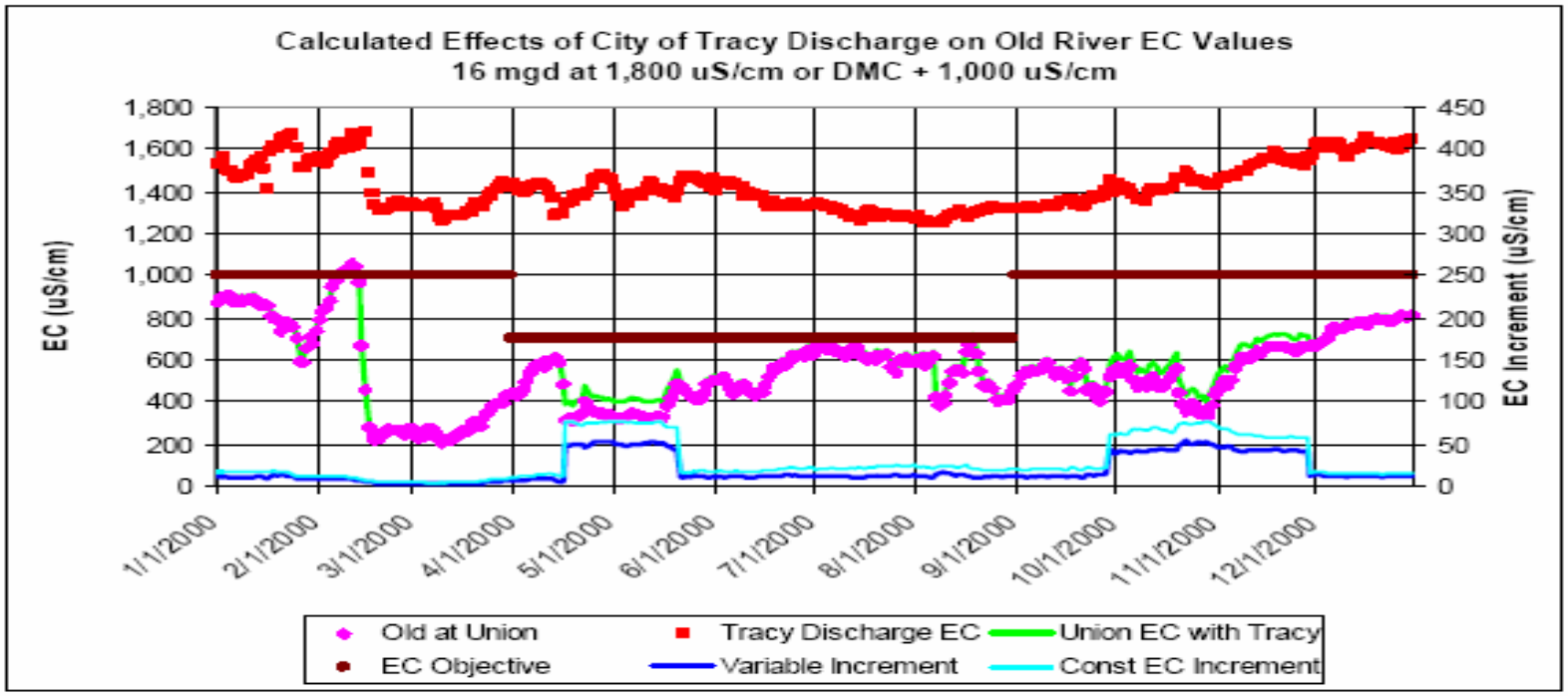

Estimated Old River Flow
Estimated Old at DMC = 12.5% Head of Old River
Flow (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Vernalis
Vernalis - Stockton
Estimated Old River
Old River at DMC

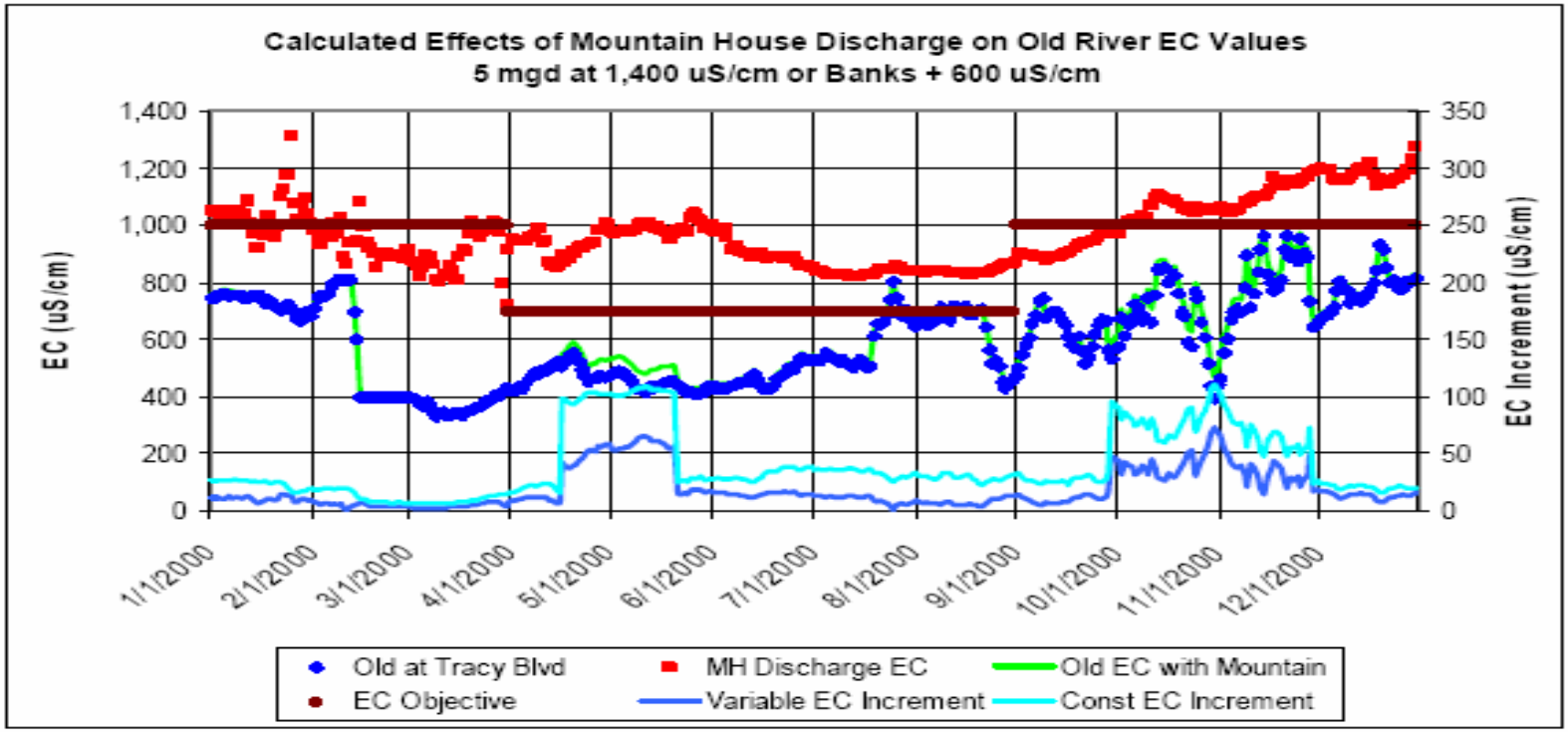

San Joaquin River EC Measurements
EC (uS/cm)
1,200
1,000
800
600
400
200
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Rough & Ready
Brandt Bridge
Mossdale
Vernalis
EC Objective


San Joaquin River and Old River EC Measurements
EC (uS/cm)
1,200
1,000
800
600
400
200
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Old at Tracy
Old at Union
Mossdale
DMC
Vernalis
EC Objective
Banks


Calculated Effects of City of Tracy Discharge on Old River EC Values
16 mgd at 1,800 uS/cm
EC (uS/cm)
Flow (cfs)
1,200
1,000
800
600
400
200
0
3,000
2,500
2,000
1,500
1,000
500
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Old at Tracy Blvd
Old at Union EC
Union EC with Tracy
Tracy EC Increment
EC Objective
Flow at Tracy


Calculated Effects of Mountain House Discharge on Old River EC Values
5 mgd at 1,400 uS/cm
EC (uS/cm)
Flow (cfs)
1,200
1,000
800
600
400
200
0
300
250
200
150
100
50
0
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
Old at Tracy Blvd
Old at Union
Old EC with Mountain
Mountain EC Increment
EC Objective
Flow at Mountain


Calculated Effects of City of Tracy Discharge on Old River EC Values
16 mgd at 1,800 uS/cm or DMC + 1,000 uS/cm
EC (uS/cm)
EC Increment (uS/cm)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
450
400
350
300
250
200
150
100
50
0
1/1/2000
2/1/2000
3/1/2000
4/1/2000
5/1/2000
6/1/2000
7/1/2000
8/1/2000
9/1/2000
10/1/2000
11/1/2000
12/1/2000
Old at Union
Tracy Discharge EC
Union EC with Tracy
EC Objective
Variable Increment
Const EC Increment


Calculated Effects of Mountain House Discharge on Old River EC Values
5 mgd at 1,400 uS/cm or Banks + 600 uS/cm
EC (uS/cm)
EC Increment (uS/cm)
1,400
1,200
1,000
800
600
400
200
0
350
300
250
200
150
100
50
0
1/1/2000
2/1/2000
3/1/2000
4/1/2000
5/1/2000
6/1/2000
7/1/2000
8/1/2000
9/1/2000
10/1/2000
11/1/2000
12/1/2000
Old at Tracy Blvd
MH Discharge EC
Old EC with Mountain
EC Objective
Variable EC Increment
Const EC Increment

Managing South Delta EC

- South Delta Salt Load dominated by SJR
- Agricultural uses may increase EC by 10%
- Maximum municipal discharges will add 75,000 tons/year (7.5% of average SJR load)
- The EC objectives at Vernalis therefore generally protect the South Delta EC
- The possibility of reducing CVP and SWP export EC should be seriously pursued